THE

FOUNDRY TRADE JOURNAL

WITH WHICH IS INCORPORATED

THE IRON AND STEEL TRADES JOURNAL

VOL. 62 Thursday, May 30, 1940 No. 1241

PUBLISHED WEEKLY

Subscription Terms : 17s. 6d. per annum.
Foreign and Colonial : 20s. per annum.
All Subscriptions are payable in advance.

THE FOUNDRY TRADE JOURNAL
49, Wellington Street, London, W.C.2.

EMERGENCY ADDRESS
to which all communications should be sent until further notice :—
3, Amersham Road, HIGH WYCOMBE, Bucks.
Telegraphic Address : "Zacatecas, High Wycombe."
Telephone : HIGH WYCOMBE 1792 (3 lines).

OFFICIAL ORGAN OF
The Institute of British Foundrymen
The Institute of Vitreous Enamellers
The Welsh Engineers' and Founders' Association
The Foundry Trades' Equipment and Supplies Association

Institute of British Foundrymen
PRESIDENT : 1938-39
W. B. Lake, J.P., Lake & Elliot, Limited, Braintree, Essex.

LIST OF SECRETARIES—
General Secretary : T. Makemson, Saint John Street Chambers, Deansgate, Manchester, 3. London Office : 49, Wellington Street, London, W.C.2.
Birmingham, Coventry and West Midlands : A. A. Timmins, A.I.C., 21-23, St. Paul's Square, Birmingham, 3.
East Midlands : S. A. Horton, "Three," Mostyn Avenue, Littleover Derby.
Lancashire (*pro tem*) : A. Boyes, "Roseville" 7, Kirkstall Road, Davyhulme, Manchester.
London (*pro tem*) : H. W. Lockwood, Stewarts and Lloyds, Limited, Winchester House, Old Broad Street, E.C.2
Middlesbrough : (*pro tem*) : J. K. Smithson, North-Eastern Iron Refining Company, Limited, Stillington, Stockton-on-Tees.
Newcastle-upon-Tyne : C. Lashly, Sir W. G. Armstrong, Whitworth & Company (Ironfounders), Limited, Close Works, Gateshead.
Scottish : J. Bell, 60, St. Enoch Square, Glasgow.
Sheffield : T. R. Walker, M.A., F.I.C., 11, Broomgrove Crescent, Sheffield, 10.
Wales and Monmouth : J. J. McClelland, 12, Clifton Place, Newport.
West Riding of Yorkshire : S. W. Wise, 110, Pullan Avenue, Eccleshill, Bradford.
South Africa : F. C. Williams, Mutual Building, Corner of Harriston and Commissioner Streets, Johannesburg.

Bristol : A. Hares, Park Crescent, 648, Stapleton Road, Bristol, 5.
Burnley : H. Buckley, Ellsmere, Norfolk Avenue, Burnley, Lancs.
East Anglian : J. L. Francis, 12, Glenhurst Avenue, Colchester Road, Ipswich.
Falkirk : T. R. Goodwin, "Viewfield," Falkirk Road, Bonnybridge, Scotland.
Lincoln : E. R. Walter, M.Sc., The Technical College, Lincoln.

The Institute of Vitreous Enamellers
President : Professor J. H. Andrew, D.Sc., Department of Applied Science, The University, St. George's Square, Sheffield.
Chairman : W. H. Whittle, W. H. Whittle, Limited, Eccles, near Manchester.
Hon. Secretary : Dr. G. T. O. Martin, 49, Wellington Street, Strand, London, W.C.2.

Foundry Trades' Equipment and Supplies Association
President : G. E. France, August's, Limited, Thorn Tree Works, Halifax.
Secretary : K. W. Bridges, Grand Buildings, Trafalgar Square, London, W.C.2.

Welsh Engineers' and Founders' Association
President : W. E. Clement, Morfa Foundry, New Dock, Llanelly.
Secretary : J. D. D. Davis, 9, Royal Metal Exchange, Swansea

BRITISH CAST IRON RESEARCH ASSOCIATION
The Registered Office and Laboratories of the B.C.I.R.A. are :—
21-23, ST. PAUL'S SQUARE, BIRMINGHAM
Telephone : Colmore 4274-4275 Telegrams : CIRA
The B.C.I.R.A. Scottish Laboratories are :—
Foundry Technical Institute, Meek's Road, Falkirk
Telephone : 332

Contents

	PAGE
Government Control	393
Book Review	394, 406
I.B.F. Cheltenham Conference Abandoned	394
South African Foundry Trade Developments	394
Publication Received	394
Random Shots	394
General Steel-Foundry Practice	395
War-Damaged Factories	396
A General-Utility Non-Ferrous Casting Alloy	397
The Temperaments of Melting Units	400
A National Savings Week	402
Electric Motor Castings in Green Sand	401
Application of Cast Iron in Modern Automobile Construction	403
Founders' Forum	406
The Week's News in Brief	408
Trade Talk	408
Personal	408
Obituary	408
Contracts Open	408
Reports and Dividends	408
Company Meetings	408
Forthcoming Event	408
Raw Material Markets	410

Government Control

It is in no spirit of panic that the Government have assumed control of all persons and property in order to marshal the entire resources of the nation to meet the danger which at this moment threatens our very existence as a free people. Although the Bill, which occupied but a single sheet of paper and was passed through its various stages on Wednesday of last week in about three hours, places us and all we possess at the disposal of the State, the bold step taken by the Government has been received with a sense of relief by the country as a whole. Everyone realises as "The Times" so aptly puts it that "Our ancient liberties are placed in pawn for victory; nothing less than the destruction of Hitlerism will redeem them." That realisation is sufficient to compel each one of us to place himself or herself willingly and unreservedly in the hands of the Government, in the interests of the high cause in which we and our gallant Allies to-day are fighting in France and elsewhere.

Mr. Attlee, introducing the Bill, allayed any fears that the measures to be taken might not fall equally upon all sections of the community by pointing out that all private interest must give way to the urgent needs of the community. On the majority of people the provisions of the new Bill will have little effect. Obviously at a time of crisis it is the duty of the Government to see that every citizen is usefully employed. It may be difficult in many occupations to draw a clear line of distinction between those who are doing a national service and those who could be more usefully engaged than they are at present. These represent a minority. There are, however, a great many people doing work of various kinds obviously unnecessary as a contribution towards the present effort, and, as circumstances dictate, they may be asked to give up their normal means of livelihood and to undertake work of national importance in accordance with their natural abilities. One may expect the unemployed first to receive attention, for there are so many directions in which they could be occupied that this unused reservoir of labour constitutes a most serious loss of productive effort.

Control over property is considered equally important in our war effort. There is to be no profit made out of the national emergency, and the Excess Profits Tax is to be 100 per cent. Actually, over a wide field industry no longer will be carried on for private profit only; it will be operated in the sole interest of the community. Firms engaged on munitions will be brought under Government control, while establishments unable to make a profit and which otherwise would go out of business, may, if it is considered necessary, be instructed to carry on, even at a loss, although in such cases suitable adjustments would be made to compensate the proprietors. Other concerns may be ordered to close for the duration. The question of compensation, of course, arises under those conditions but that aspect of the problem has not been overlooked.

Even with the full text of the Limitation of Dividends Bill, one cannot be sure about the effect of this measure, but its intentions are clear, *viz.*, to limit the spending power of individual shareholders and to "take the profit out of war." For companies established before the war, the ordinary dividend which they may pay in respect of any accounting period between June 30, 1939, and the end of the war period must not exceed the maximum distribution which the company has made in any one of its three financial years which ended after June 30, 1936. A company which paid nothing or only a small dividend during the standard period may pay up to 4 per cent. if its earnings permit. New companies, *i.e.*, those whose first accounting period did not end until after July 1, 1939, may pay 5 per cent.

A Production Council is to be set up including representatives of the chief Government Departments concerned with munitions, including the Admiralty, Aircraft Production, Ministry of Supply, Ministry of Labour and the Mines Department. Finance and the banks are being brought under Government control. These and other provisions designed to marshal the resources of the country, should go far towards enabling us to throw our full weight into the present struggle and to ensure final victory.

Book Review

Proceedings of the American Society for Testing Materials, 1939. Published by the Society, 260, South Broad Street, Philadelphia, Pa. Price: heavy paper, $8.50; half leather, $10.

The Proceedings of the 1939 annual meeting of the Society are now issued in one volume under a new publication scheme, by which all new tentative standards (formerly published in Proceedings) are included in the 1939 Book of Standards, thus enabling the former two volumes—Part I, Committee Reports, and Part II, Technical Papers—to be combined. The present edition covers some 1,350 pages.

Not only do the reports of the A.S.T.M. committees give full details of the important recommendations on specifications and standardised test methods for materials, but in many cases they include important data and information in the form of appended section reports or Papers. Eleven of the reports pertain to ferrous metals, including extensive reports on field tests of metallic coatings on wire and wire products. Reports on inspection of stainless steel and metallographic examination of 18 per cent. chromium, 8 per cent. nickel alloy, are given. Also included are reports on effect of temperature dealing with grain size, torsion tests and correlations of test results.

Seven of the reports are on non-ferrous metals and alloys, and include extensive technical data on galvanic and electrolytic corrosion tests, proposed classification of cast copper and copper-base alloys, and a discussion of magnesium alloy die-castings.

Other reports classified under the general heading "miscellaneous materials" pertain to paint, varnish, lacquer, and related products; petroleum products and lubricants; gaseous fuels; road and paving materials; coal and coke, and many other subjects.

Preceded by the Fourteenth Edgar Marburg Lecture on "Stress, Strain, and Structural Damage" by Prof. H. F. Moore, are twenty technical Papers dealing with metals, sixteen covering cement and masonry materials, eight comprising the Symposium on Shear Testing of Soils, and fifteen covering miscellaneous materials and subjects. Topics dealt with in the Papers on metals include work-brittleness test, testing block for heat-resisting alloys, mechanical properties of cast iron, contributions on radiography, and mechanical tests on aluminium alloys. In the cement and masonry group are Papers covering particle size distribution.

Other technical Papers cover laboratory wet gas meters; tests of rubber and rubber-like materials; five items on industrial waters—particularly boiler feed water; two Papers on Rockwell hardness, and a study of the influence of speed on the torsion impact test.

South African Foundry Trade Developments

The increasing importance of the foundry industry in South Africa is instanced by a recent development which has taken place within the Transvaal Engineers' and Founders' Association whereby the foundry trade has become sectionalised under its own executive committee, known as the Foundry Trade Committee of the Association. Since the activities of the Committee will embrace both iron and steel founders, a liaison has been established with the Transvaal Iron and Steel Manufacturers' Association, of which the larger steel founders are members.

The Committee will seek to improve the position of the foundry trade generally, and will, among other things, endeavour to improve scrap supplies, and to arrange reasonable prices. The members are the following:—Mr. V. L. Dean (chairman), Mr. D. M. Davidson, Mr. A. J. Taylor, Mr. A. E. Lintott, Mr. W. J. Petersen, Mr. J. C. Milburn and Mr. G. S. Graham. Dr. H. J. van Eck represents the Transvaal Iron and Steel Manufacturers' Association on the Committee, with Mr. C. Cartwright as his alternate.

The Chamber of Mines has accepted that the prices of scrap ex-mines direct to founders shall be 80s. per ton for grey and 60s. per ton for white iron, as has been the position for a number of years. It has been further recommended that arisings on mine properties shall be made available direct to founders and not be passed through dealers.

There are twenty-eight signatories to a gentlemen's agreement entered into between founders to prevent unreasonable bidding for scrap arisings, and to exercise a measure of control over prices demanded by dealers, the maximum price agreed upon as from April 15, 1940, being 90s. per ton for best grey machinery scrap broken up for cupola use in pieces of not more than 100 lbs. in weight. Inferior qualities are to be at appropriate figures based on the maximum.

Publication Received

Bristol Engineering Directory and West of England Buyers' Guide. Issued by the Bristol Engineering Manufacturers' Association, 104, Felton Avenue, Bristol, 7.

This booklet, which is available to our readers on sending a 2½d. stamp to the Association, details the character of the engineering works and scientific societies located in the Bristol area. A certain amount of engineering data is also included.

I.B.F. Cheltenham Conference Abandoned

In view of the gravity of the situation and also because so many foundries are operating seven days a week, the Executive Committee of the Institute of British Foundrymen has decided to cancel the Conference which was arranged to be held at Cheltenham on June 7 and 8.

It is realised that this decision will cause disappointment and inconvenience, but the Executive Committee felt that in spite of this disappointment and inconvenience, their decision would meet with approval of the members. Copies of the Papers which were to have been presented will be circulated to all who intended to participate, in accordance with their requests, and to any other members who apply for them. Written discussion on these Papers is invited, and contributions should be sent to Mr. J. Bolton, St. John Street Chambers, Deansgate, Manchester 3. The Papers and discussions will be published in THE FOUNDRY TRADE JOURNAL and the Proceedings of the Institute.

It is hoped that the business meetings arranged for June 7 and 8, namely, the annual general meeting, Council meeting, and committee meetings, will be held at a later date.

Random Shots

A great deal is heard of the child evacuee; of the hardships of separation from the family; of the troubles of their "hosts"; and more happily of the benefits the kiddies have derived from the unaccustomed country life. One hears little, however, of the adult evacuee, but the following pathetic little picture, taken from real life, shows that even the adolescent evacuee has his (or her, in this case) minor hardships! It was the lunch hour, and Mary, a junior typist "living in" at the wartime country quarters of her firm, was sitting on the lawn writing a letter. It was a lovely day, with a bright sun lighting up the blossom on the surrounding trees. Most of the staff were enjoying a quiet half-hour somewhere in the garden. All at once came a pathetic little voice from Mary. "Joan," she called across the garden, "are there two n's in lonely?"

* * *

A great deal is also heard of fifth column activity, and the following little story is a warning to all careless and untidy people. The other day "Marksman" (who must be put in that category too), thinking to lighten his daily burden and at the same time to support the waste-paper campaign, decided to "turn out" his pocket wallet. Amongst the accumulation of two or three years was the following junk:—(1) At least four scraps of paper with times of trains scribbled on them. (2) An address in Le Touquet. (3) The visiting card of an electrical engineer in Normandy, complete with name of country inn near Southampton where he proposed to spend a summer holiday. (4) The visiting cards of at least six German business men. (5) A portion of a letter from a friend in the country which read "You are safe for a good dinner next autumn as I have just made sure of a good gun for next August!" (6) A scrap of paper bearing the following cryptic information: No. 346. 15 × 14. Wm. Royal Cypher.

* * *

And the moral of all that is, turn out your pockets before the police do it for you! An over-zealous and imaginative cop, out for a scoop, could have found in that wallet enough evidence to get a fellow into gaol for the duration!

* * *

Shortly after the proclamation which ordered a seven-day week for vital war industries, "Marksman" happened to pick up a recent issue of the "South African Engineer and Foundryman." This is what the "Personal Notes" mainly contained:—

Mr. —— has just returned from a month's holiday in Durban.

Mr. —— is away in Capetown on a month's holiday.

Mr. —— is spending a month's holiday at the Cape.

Mr. —— is away on holiday at the Cape. It is uncertain when he will return.

* * *

Lucky South Africa! In England men have long learned to think of that country as the land with the perfect climate, but after the war it will have an added attraction as "the land where they give you a month's holiday"!

* * *

The Lesser of Two Evils?

"How did you persuade your father to send you to college for another year?"

"I told him that if he didn't, I'd get married, and I guess he thought he couldn't afford that."

* * *

The London bus conductor does not mean to lose his reputation for humour even if there *is* a war on. This is how one announced a bus stop the other day. "Alight here for Oxford Circus. Waring & Gillow's on your left. Littlewood's on your right." "MARKSMAN."

General Steel-Foundry Practice*

BRITISH AND OVERSEAS METHODS COMPARED

By A. BUTTON

The steel-foundry industry in Great Britain is chiefly of a jobbing nature. By this is not meant that it does not make use of moulding machines, etc., but mechanised production as used in iron and non-ferrous foundries is rare. The principal British steel foundries specialise in one or two lines, *i.e.*, several Sheffield firms make dredger parts, buckets, tumblers, etc., whilst others on the North East Coast concentrate on rolls, and only do a very small proportion of general jobbing work. During recent years great strides have been made in British foundry practice, and to-day the foundryman is looked upon as an artist and skilled craftsman. All the leading foundries are now modernised, and equipped with the latest appliances both for production and research work.

For the production of clean, sound castings, on an economical basis, there are three essential points—the quality of the steel received from the furnace, the sands, and casting design. Unfortunately, until recently, the foundryman had little control over the last factor. The customer or his engineer sent in a blueprint which had not taken into consideration cooling stresses, etc., with the result that more often than not heavy sections abutted on to light sections, and shrinkage cavities, sharp edges at corners, and numerous other defects resulted. It is now almost a universal practice to consult the foundryman on design, when with a little common-sense modification, which in no way affects the utility of the casting and usually gives a sounder and better job for the purpose required, the foundryman is enabled to supply a sound, solid casting, as against a casting that invariably had to be welded in several places.

Sands

To the foreman moulder sand is the most important item. A moulder may be highly qualified, yet, if his sand is not suitable for the work on hand, it is inevitable that he will have scabs, washes, porous and dirty castings, as well as throwing a lot of unnecessary work on the fettling shop. With steel founding in particular, personal experience is that there is no hard-and-fast rule, and every foreman appears to have a mixture of his own. This is all to the good, for almost invariably he produces good castings.

In South Africa the foundryman is greatly handicapped as compared with those of Great Britain, in that he has not the choice of good sands (as yet), and further, due chiefly to cost, makes little use of bonding materials, etc. In Great Britain the amount of proprietary bonding materials used in steel foundries is very large. In one British foundry, turning out 100 tons of castings per month, the shop used approximately 20 barrels of a proprietary brand of binder, and 1 ton of bentonite, but it was found that this expenditure was repaid in the quality of the castings, the bulk of which were comparatively small, weighing an average of 20 lbs., and all for the Service departments.

Up to a few years ago, it was rare to make a steel casting in green sand. Now, for small and medium castings up to 5 cwts., this is more or less universal in Britain. In the foundry referred to, practically all the work was machine moulded on jolt-squeeze pattern-draw machines, taking boxes from 16 by 12 in. up to 24 by 24 in., and a still larger machine for a specialised job. All the work done on these machines was in green sand, and the boxes were used several times a day.

Melting and Pouring

A 15-cwt. electric-arc furnace gave a heat every 1½ hours, *i.e.*, 6 heats per day of 9 hours. The furnace was tapped into a bottom-pouring ladle, taken by the electric crane to the casting bay, where the mixture was poured into 100-lb. shanks, and the moulders cast their own work, running three shanks at a time. This was not only a much quicker way of casting than moving the crane ladle over each individual box, but cleaner castings were produced, and the amount of spillage was practically nil.

To each pair of moulders carrying a shank, two labourers were allotted, one to skim as they were pouring, for, although the metal was bottom-poured from the ladle, a certain amount of slag, scum, etc., always accumulates, and when the castings have a quantity of machining on them, the slightest amount is sufficient to condemn them under the severe inspection imposed. The other labourer had a tin of flux, and immediately the metal came up in the heads, he threw on the flux, and also on the gate, and if there was a heavy section in the casting, a larger riser was added, and he fed it down with a bamboo on a thin stick for a few minutes.

Immediately casting was over, the moulders would be back at their machines, and the labourers would sling the boxes by the crane, taking about six pairs at a time, run them along the shop, knock them out on the sand heap, then return the boxes to the moulders, pull the castings out of the sand, and stack them near the sand-blast.

Sand Mixtures

The mixture of sand used was 3 parts of silica sand, having an analysis of SiO_2 94 per cent., Fe_2O_3 4 per cent., Al_2O_3 1.17 per cent., and seven parts of old sand, with an addition of 1½ shovels of a proprietary oil binder and 1 shovel of bentonite to 3 barrow loads of sand carrying 3 per cent. moisture. With this mixture the castings—and some were very intricate, the bulk being for motor vehicles and railways, and the simplest being the wheel hubs and drawbar hooks—were left like glass when the sand fell off. For core sand 3 parts silica sand, 3 parts red sand, 4 parts of old sand, 1½ per cent. of a proprietary oil binder, and 1 quart of raw linseed oil, to 3 barrow loads of sand were used. It carried 4 per cent. moisture. With this, the cores dropped out when lightly tapped with a 4-lb. hammer.

For the heavy work—from over 5 cwt. to ½ ton—the foundry made its own composition by adding 10 per cent. each of fine-ground firebrick and old crucibles; the moulds were coated with silica paint. If it was a solid lump, such as a hammer block, it was stove-dried. When it was not a solid compact lump, such as a crown wheel, base plate, etc., it was skin-dried with a Mond gas jet.

A considerable amount of high alloy steels, such as heat-resisting, stainless, etc., was made. These were all extremely small castings, averaging 3 lbs. each. The metal was melted in a high-frequency furnace, the shop being equipped with three such furnaces of 3-cwt., 5-cwt. and 10-cwt. capacity. All these castings were poured green, and after numerous trials the most suitable sand was found to be Mansfield red, with 1½ per cent. bentonite. This gave a clean, sharp casting, showing up every mark on the pattern. For heavy work, while some foundrymen claim to get excellent results when casting green, the author does not favour this practice.

When casting rolls, mill housings, heavy gear wheels, tumblers, etc., weighing up to 30 tons, the best results were obtained when using a composition, the mixture varying according to the materials available. It can therefore only be given in general terms. It consists of broken firebrick, old crucibles finely ground, silica sand, a small percentage of fireclay and, when obtainable, additions of proprietary binders and bentonite. The percentage of each depends greatly upon the raw materials available. The sand or compo should be sufficiently high in silica to be refractory, so that it may not be melted or softened by the heat of the steel. The average size and shape of the particles are also of importance, since they affect the porosity and binding power of the sand. The sand should not be too moist, as it is then prone to flake and spall in drying, rendering necessary a good deal of patching when closing the mould. Also, if the sand is too wet, it packs so hard as to be impervious to the escape of gases. This invariably results in blowholes in the steel.

In some foundries it is the practice to paint very heavy moulds with coal tar after they come out of the stove, but a much better method, and one which gives a cleaner skin, is to wash the surface with silica paint.

Far-Eastern Foundry Practice

Some years ago the author was in charge of a steel foundry in Hong Kong which produced castings up to 3 tons in weight. All the fairly heavy castings were stove-dried, and, as nothing was used but local products, a good deal of experimenting had to be done before finding a suitable sand mixture. The binding material used was almost exclusively molasses, principally due to the fact that there was a large sugar refinery almost next door, and the material was therefore cheap.

Melting Plant

Practically no crucible casting is now done in Britain, for with the introduction of electric furnaces, the cost of melting is greatly reduced by installing such a furnace. In the Hong Kong foundry referred to, there were originally 12 three-pot furnaces (200 lbs. each), giving a heating of 7,200 lbs. of steel when all the fires were on. This plant frequently produced castings weighing up to 5,000 lbs., chiefly propeller brackets, stern posts for small craft, bedplates, etc. On one occasion the foundry by this process made 36 sections of bedplates; the average length of each was 11 ft., the weight 35 cwts., and heaviest section ¾ in.

Later a 2½-ton Greaves Etchells arc furnace was installed, and the crucible fires were kept as a standby, and used only on occasions when there was a very heavy job, but it was a daily occurrence to pour castings up to 600 to 700 lbs. each—mainly lining plates for the cement works, tumbler slabs, etc., for dredgers in manganese steel, locomotive wheel centres and steam chests in carbon steel—from the crucibles.

Advantages of Electric Furnaces

The electric furnace is fast displacing the converter and open-hearth processes for steelmaking in foundries, despite the higher cost of melting, the reasons being the acknowledged higher quality of electric steel, and the adaptability of the furnace to varying conditions.

In the basic electric furnace it is possible to remove the most injurious impurities, *e.g.*, sulphur and phosphorus, more completely than by the open-hearth or converter process, and, at the same time, the steel can be freed from dissolved or suspended oxides. In electric furnaces, and only in this manner, it is possible to cover the steel with a slag of almost pure silicate of

D

* Paper read before the South African Branch of the Institute of British Foundrymen.

lime, and work the steel with ferro-silicon so that furnace conditions are strongly reducing instead of oxidising as in the other processes, and the last traces of oxides are converted into metallic form. At the same time, the gases which molten steel usually holds in solution are largely eliminated, and a steel is produced which is almost pure. The ease with which electric steel containing low carbon, say 0.3 per cent., and small amounts of silicon and manganese (0.9 per cent.), can be poured into small and intricate castings, setting quickly in the sink heads, and producing castings by semi-skilled labour with hardly a trace of blowholes, is largely due to its purity.

Due to the high cost of electricity in many districts where there are large steelworks, the duplex system is coming strongly to the fore for foundry work, *i.e.,* they melt the steel in the open-hearth or Bessemer plant, and refine it in the electric furnace in the foundry.

In the acid open-hearth process, no phosphorus or sulphur is removed, and there is even a slight gain in these impurities, while in the basic open hearth conditions are such that phosphorus and sulphur are largely eliminated, yet more strongly oxidising slags are used in the basic furnace, and in order to facilitate the removal of phosphorus and sulphur, the steel is often refined down to a very low content of carbon, which makes it more easily oxidised, and hence promotes the absorption of oxides. Add to this the fact that very impure grades of scrap are largely used in the basic furnace, and that the deoxidising additions are so used that their effect is much less complete than in the acid practice, and there are many considerations that point clearly to the superiority of acid over basic open-hearth steel.

In Bessemer steelmaking, air is blown through a bath of iron containing much carbon, silicon and manganese, or a blast of air is projected strongly upon the surface of such a bath. By the oxidising action of the air, the carbon, silicon and manganese are converted into CO gas and to SiO_2 and MnO, the first escaping, the other two forming slag. That much iron must at the same time be oxidised where the excess of air is great, especially at the end of the blow when the iron is no longer protected from such oxidation by carbon, silicon and manganese, is axiomatic, and is conclusively proved by the considerable loss of iron in conversion. It is undeniable that the oxidation by the blast is greater than in the open-hearth furnace by the gases and the oxidising slag. At the end of the blow, after the maximum oxidation has taken place, the vessel is at once turned down containing a steel very rich in oxides and gases (as shown by its wildness if poured at once), and Fe-Si and Fe-Mn are added to reduce the oxides. In the open-hearth process, the oxidising conditions grow less severe as the process proceeds, and the steel is boiled for some time, during which it frees itself from part of the oxides absorbed in the earlier stages of the process.

It will be gathered from the above remarks that in personal experience of the various processes of steelmaking, the electric furnace is most suitable for general foundry practice. The crucible process, due to the high cost of fuel per ton of castings, coupled with the limited tonnage production, is uncompetitive unless one is working on very high-quality castings which demand a high price.

The open-hearth process is ideal, providing there is a large tonnage of comparatively heavy castings, for the smallest furnace of this type it is economical to run is 15 to 20 tons, and it should be run continuously for the 24 hours, otherwise there is always a danger of running into furnace trouble due to contraction and expansion on the walls and chequers. There are but few jobbing foundries which can keep a 15- to 20-ton furnace running continuously from Monday morning to Saturday noon, and unless this can be done the open-hearth furnace is not economical to operate.

On the other hand there are electric arc furnaces from ½ ton up to 25 tons capacity. They can be run one day, and left for two or three, with little disturbance to the furnace. The high-frequency furnaces, which in first cost per ton capacity are much higher than the arc type, cost much less to operate,* *i.e.,* current and upkeep. They are built as small as 1 cwt. capacity, and are very simple to operate.

One fatal mistake made by ironfounders when starting steel founding is reducing the size of the risers, and it is quite a common practice in the most progressive steel foundries to have the risers about 50 per cent. of the weight of the casting.

Heat-Treatment

The heat-treatment of steel castings is to-day receiving very close attention, and large sums of money are being spent by all important steel foundries on research work in this department.

In general foundry practice there are four main types of annealing oven—solid fuel fired, gas, oil and electric. The last, although the most expensive in first cost, is undoubtedly the most economical to operate and gives greater control over the products. The best results personally obtained in heat-treatment were with an electric annealing oven, operating mainly on low-carbon steels and high-alloy steels, *i.e.,* copper chrome and nickel chrome.

This oven was 8 ft. wide, 8 ft. high, and 12 ft. long, with a balanced door at each end. The electric elements ran all along each wall and round the roof. The castings were loaded on to a truck, the platform of which was made of firebrick, and were hauled into the oven by a snatch block. Both doors were sealed, and the current switched on. The average time taken to get the heat up to the required temperature was one hour, when with the automatic control, the temperature was held at that for the required period. Taking medium-sized carbon steel castings, this was one hour, when the automatic switch again came into operation, and switched off the current.

The castings were left in for approximately one hour longer, by which time the temperature had dropped to approximately 550 deg. C., and were then withdrawn, the truck discharged, and the castings left to cool normally. The annealing plant was inside the shop, with the result that the castings were not subjected to cold winds when taken from the oven.

During the period that one truckload was under heat, the truck at the other door was being loaded. When pulling the one truck out with a snatch block, the newly-loaded truck was coupled on to it, and took up its position in the oven.

Heat-Treatment of Alloy Steels

With steel castings of 0.3 to 0.35 per cent. C, 1.0 per cent. Mn, 0.04 per cent. sulphur and phosphorus, tensile strengths of 32 to 35 tons per sq. in., associated with 18 per cent. elongation and cold bend of 90 deg., were invariably obtained. With Ni-Cr steel castings, great care must be taken in the heat-treatment, and it is a very common practice to give such castings a secondary treatment when specially hard service is required. On a Ni-Cr steel of C 0.35 per cent., Ni 1.75 per cent., and Cr 0.7 per cent., annealed at 950 deg. C., oil-quenched, re-annealed at 850 deg. C., and then air-cooled, the following mechanical tests were obtained: M.S., 45 tons per sq. in.; elongation on 2 in., 25 per cent.; R.A., 45 per cent.; and Brinell hardness, 350.

Manganese and low-chrome steels are well known in South Africa. In the former case,

(Continued at foot of next column.)

* Our information is that operating costs approximate to those of an electric arc furnace of equal capacity.—Editor.

War-Damaged Factories

LOANS FOR REPAIRS

A notice issued by the Board of Trade explains to owners and occupiers of factories, warehouses and other industrial buildings in what circumstances loans may be granted towards the cost of repair of damage caused by enemy action. Such loans are available only for the repair of buildings and reinstatement of plant which are essential to the welfare of the civil population or essential for war purposes. Copies of the explanatory notice are available from the Ministry of Health regional headquarters.

Owners and occupiers of industrial buildings who have not sufficient of the materials for making temporary repairs and cannot obtain them from the usual sources of supply, may be able to obtain them from the Government reserves of these materials which are being accumulated in various parts of the country; application should be made in the first instance to the Clerk of the Town or District Council for the area in which the damaged premises are situated. If it is necessary to limit the supplies which can be made available from Government reserves, priority will be given to undertakings engaged on work of national importance.

If more extensive repairs are necessary to enable work to be resumed and it is impossible otherwise to find the money to pay for them, it may be possible to obtain a loan from the Government, provided that it is essential in the national interest that the work of the establishment in question should be carried on. No assistance whatever can be given for the repair of unessential factories or buildings.

The procedure for obtaining a loan differs with the type of building. In the case of firms essential for civilian purposes, other than public-utility undertakings, forms of application can be obtained from the Regional Headquarters of the Ministry of Health, or in Scotland from the office of any Town or County Council, and should be sent to the Industries and Manufacture Department, Board of Trade, Great George Street, London, S.W.1. Public-utility undertakings should send their forms of application (obtained as above) direct to the Government Departments with which they are normally in contact. Undertakings essential for the production of war material for the Admiralty, War Office, Air Ministry and Ministry of Supply which, owing to war damage, have become incapable of use for these essential purposes, may apply for loans. In such cases communication should be made direct with the Department with which the firm has the closest relations; and, where stores are being produced for more than one of these Department, with that Department with which the firm has the largest orders.

(Continued from previous column.)

12.5 per cent. Mn is acknowledged to be ideal, but even this is useless if the castings are quenched at or below 1,000 deg. C. By the combined effect of C, Mn, and rapid cooling, manganese steel is rendered entirely austenitic, and very tough, because the transformations are almost suppressed. In the cast condition, when heated and slowly cooled, manganese steel is very brittle, owing to the partial transformation of the austenite, and to the liberation of free carbides of iron and manganese. As the steel is quenched from a high temperature—1,000 deg. C.—the castings, if of unequalled section, are left in a state of heavy stress; hence cracking will occur in the castings if not quenched at a high temperature. Relief of this quenching stress is very difficult, as to reheat the steel to a temperature high enough to ameliorate it results in a great brittleness.

The brittleness of the steel when cast, its high shrinkage, which results in heavy stresses when cooling in the mould and in treatment, and its low thermal conductivity, make the design and heat-treatment of manganese steel castings of complicated shape much more difficult to handle than plain carbon steels.

A General-Utility Non-Ferrous Casting Alloy*

By A. DUNLOP

The number of non-ferrous casting alloys used in engineering is extremely large. While many of these alloys are basically similar, differing only in some minor detail, there are also included in the large variety alloys which are of distinct types, each type requiring a different technique and often a specialised knowledge. Foundries are forced to handle several alloys in order to meet the different specifications. This necessity for constant variation in procedure to meet the different mechanical specifications is highly inefficient, and militates against the regular production of articles of uniformly good quality. Any development which, while still allowing the different mechanical specifications to be met, at the same time would reduce the number of alloys to be handled in the foundry, should be very welcome.

The casting alloys which are to be discussed in this Paper are those in which copper is the predominant element. It is unlikely that there will be developed an alloy of this type which, in the "as-cast" condition, will have such mechanical properties that it could successfully meet a very wide range of specifications. However, the development of alloys suitable for sand casting which are susceptible to heat-treatment has made available material which, by suitable modification of a simple heat-treatment, has a much enlarged range of properties.

In 1928 Price, Grant and Phillips[1] reported that certain alloys of copper, nickel and tin were capable of being hardened by ageing. In 1934 Wise and Eash[2] reported further data on this phenomenon, their work being confined to bronze alloys containing up to 15 per cent. tin with up to 20 per cent. of nickel. Further contributions to this subject have been made from time to time by Fetz,[3] Eash and Upthegrove,[4] and by Veszelka.[5] More recently data have been published by Kihlgren,[6] who confined his work to one alloy, containing 88 per cent. copper, 5 per cent. tin, 5 per cent. nickel, with 2 per cent. zinc. Particulars are given of the mechanical properties of this alloy as sand-cast and after heat-treatment.

In this Paper it is intended to give the results obtained by the author when using the 88:5:5:2 nickel-bronze alloy, and to compare these results with the mechanical properties of three popular and typical non-ferrous casting alloys, namely, Admiralty gunmetal, phosphor-bronze and high-tensile brass.

Heat-treatment

Some idea of the range of properties capable of being obtained in the 88:5:5:2 nickel-bronze is shown by the fact that its Brinell hardness can be varied between 80 and 200 by suitably adjusting the heat-treatment. For the best properties to be obtained, the 88:5:5:2 nickel-bronze, like most age-hardenable alloys, is subjected to a double heat-treatment. The first part consists in heating at a high temperature, followed by rapid cooling, such a treatment producing maximum softness, and the second part reheating or ageing at a much lower temperature. Of the two sections of the heat-treatment, the second is the more critical, since varying the time and temperature at this stage results in a wide variation in mechanical properties.

Table I shows the effect on hardness of varying the heat-treatment. Modification of the heat-treatment is possible, and more will be said about that later. While the alloy responds so well to heat-treatment, it nevertheless has excellent mechanical properties in the "as-cast" condition. Some typical figures are given in Table II, together with figures for Admiralty gunmetal.

TABLE I.—*Hardness of Heat-treated* 88 : 5 : 5 : 2 *Nickel-Bronze.*

Heat-treatment.	Brinell hardness, 2/40/15.
None, as-cast	84
5 hrs. 760 deg. C. W.Q.	81
5 hrs. 760 deg. C. W.Q. + 5 hrs. 250 deg. C. W.Q.	117
5 hrs. 760 deg. C. W.Q. + 5 hrs. 300 deg. C. W.Q.	168
5 hrs. 760 deg. C. W.Q. + 5 hrs. 350 deg. C. W.Q.	212

It will be noticed that in every respect the 88:5:5:2 nickel-bronze is superior to the 88:10:2 gunmetal, the superiority of the Izod impact value being most marked. An impact strength of 50 ft.-lbs. is extremely high for a sand-cast bronze alloy of this Brinell hardness. The mechanical properties of the alloy after heat-treatment, together with those of high-tensile brass and phosphor-bronze, are given in Table III. The sample of high-tensile brass is typical of material which is used largely in engineering. The values given for the sample of phosphor-bronze are higher than the usual run. The actual test-piece used was taken from the bottom of a large casting, the high metal pressure and annealing effect of the large mass accounting for the above average results.

It will be noted that in all these conditions of heat-treatment the limit of proportionality and the yield point of the nickel-bronze are superior to those values for the phosphor-bronze and the high-tensile brass. The Izod impact of 36 ft.-lbs. obtained in the material aged at 250 deg. C. is considerably in excess of even the high-tensile brass.

Ageing at 300 deg. C. gives an excellent balance of properties, an Izod impact value equal to the high-tensile brass, and a limit of proportionality 2½ times greater and a yield point 1½ times this alloy.

Although the elongation has been reduced to 5 per cent. on ageing at 350 deg. C., the impact value is not dangerously low. As a matter of fact, the Izod value of 11 ft.-lbs. is as good as that obtained in the phosphor-bronze, and, while being lower than the value already given for the Admiralty gunmetal, is as good as many samples of Admiralty gunmetal which the author has examined. Again, the very high limit of proportionality and yield point will be noticed as well as the tensile strength approaching 40 tons per sq. in.

TABLE II.—*As-cast Properties of* 88 : 5 : 5 : 2 *Nickel Bronze as compared with* 88 : 10 : 2 *Admiralty Gunmetal.*

Alloy.	Condition.	Brinell hardness, 2/40/15.	Propnl. limit. Tons per sq. in.	Yield ½ per cent. elong. under load. Tons per sq. in.	Tensile strength. Tons per sq. in.	Elong. on 2 in. Per cent.	Izod. Ft.-lbs.
88 : 5 : 5 : 2 nickel-bronze	As cast	88	6.4	10.5	22.0	35	51
88 : 10 : 2 Admiralty gunmetal	As cast	81	5.0	8.7	19.6	37	17

TABLE III.—*Properties of Heat-treated* 88 : 5 : 5 : 2 *Nickel Bronze as compared with Phosphor-Bronze and High-Tensile Brass.*

Alloy.	Condition.	Brinell hardness, 2/40/15.	Propnl. limit. Tons per sq. in.	Yield ½ per cent. elong. under load. Tons per sq. in.	Tensile strength. Tons per sq. in.	Elong. on 2 in. Per cent.	Izod. Ft.-lbs.
88 : 5 : 5 : 2 nickel-bronze	5 hrs. 760 deg. C. W.Q. + 5 hrs. 250 deg. C. W.Q.	103	10.0	14.2	22.2	38	36
	5 hrs. 760 deg. C. W.Q. + 5 hrs. 300 deg. C. W.Q.	156	16.8	21.2	34.2	18	24
	5 hrs. 760 deg. C. W.Q. + 5 hrs. 350 deg. C. W.Q.	191	24.0	30.6	38.0	5	11
Phosphor-bronze (88.25 Cu, 10.80 Sn, 0.08 Pb and 0.65 per cent. P)	As cast	113	6.5	11.0	23.6	30	12
High-tensile brass (58.87 Cu, 0.38 Sn, 0.10 Pb, 1.13 Fe, 1.03 Al and 1.00 per cent. Mn, balance Zn)	As cast	124	6.8	13.4	32.8	29	23

Production of the 88:5:5:2 Nickel-Bronze

The manufacture of castings in the nickel-bronze alloy presents no greater difficulties than are encountered when Admiralty gunmetal is used. Like any other alloy, it is not absolutely foolproof, and under certain circumstances the best results may not be obtained. As pointed out by Kihlgren,[6] if the maximum response to heat-treatment is to be obtained, contamination by lead must be guarded against; 0.05 per cent. of this element has been shown adversely to affect the response to heat-treatment. In selecting raw materials, care should be taken to use metal which is sufficiently low in lead. The nickel may be added as pure nickel or as 50:50 copper-nickel shot. When the alloy is to be

* Paper presented to the Scottish Section of the Institute of Metals.

used in the "as-cast" condition, lead is no more detrimental than it is in Admiralty gunmetal.

Failure of the alloy to give the maximum response to heat-treatment can also arise if either the tin or nickel contents become too low or if the material is unsound. No difficulty should be encountered in producing castings which are perfectly sound. One of the main causes of unsoundness in sand castings in alloys of this type, including in this connection such alloys as Admiralty gunmetal and phosphor-bronze, is unsatisfactory melting technique.

For best results to be obtained it is advisable to melt these alloys in a slightly oxidising atmosphere. The ideal melting conditions cannot always be easily obtained by simply manipulating the furnace controls, particularly in natural-draught coke-fired furnaces of the pit type.

Successful results have been obtained with the nickel-bronze in crucible furnaces which have been coke-fired, using natural draught, forced draught using oil, and forced draught using town gas. It has been found that the simplest way to ensure a slightly oxidising atmosphere in the above types of furnace is to use flux which is slightly oxidising in character. Manganese ore has been found to be very suitable for this purpose, but copper oxide can also be used. There are also on the market certain proprietary fluxes which can be recommended for the purpose.

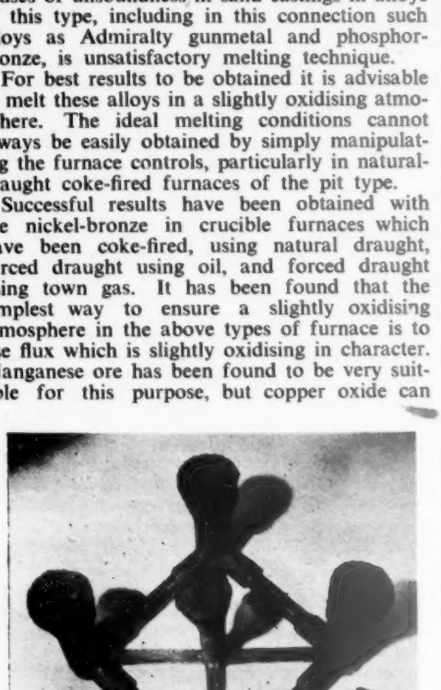


FIG. 1.—TENSILE TEST-BAR CASTING.

Satisfactory results can be obtained by using virgin metals, but it is probably the best practice, although not absolutely essential, to ingot the virgin metals before use. Melts consisting partly of ingoted new metal and partly of remelted metal, such as runners and risers, are also satisfactory, while excellent results have been obtained on using 100 per cent. remelt.

In making a melt from new metal, 2 per cent. of the weight of the charge of manganese ore is placed in the bottom of the crucible, followed by the nickel and the copper. When this is melted, and at about 1,250 deg. C., the flux is skimmed off. If the flux is too fluid, it may be thickened by adding some dry sand, or preferably lime. Following this the zinc is added and then the tin. Immediately before pouring, an addition of 0.05 per cent. of phosphorus added as phosphor-copper is beneficial. A casting temperature in the range 1,160 to 1,220 deg. C. is suitable for most types of casting.

When 100 per cent. remelt is used for the charge, as before 2 per cent. of manganese ore is placed in the bottom of the crucible, followed by the alloy. When hot enough the flux is removed, and before pouring 0.05 per cent. phosphorus is added. It is beyond the scope of the present Paper to go into detail concerning methods of gating and running. Most castings are a problem in themselves. This, of course, applies to all casting alloys. However, it will probably be sufficient to state that gating and running practice found suitable for Admiralty gunmetal will in most cases be found satisfactory for the 88:5:5:2 alloy.

Risers do not need to be used so frequently or be of so generous a size as when high-tensile brass is used; neither is there anything like the same tendency as with high-tensile brass to form dross and consequently dirty castings. The photograph in Fig. 1 shows the type of tensile bar casting used for the work given in this Paper, and is typical of successful "gating" practice for this alloy. Four bars are produced from the casting, and only 25 lbs. of metal are required to pour it. From the bar the standard 0.564 in. dia. test-piece can be machined. This casting illustrates how much easier the nickel-bronze is to feed to produce sound material when compared with high-tensile brass. It is extremely doubtful if satisfactory bars could be obtained from this type of casting if the alloy was high-tensile brass, which alloy requires a massive feeding block along the full length of the test-bar.

The 88:5:5:2 alloy has a much smoother cast surface than what is normally obtained with phosphor-bronze. This is of considerable importance in such castings as complicated impellers, which, because of their design, are difficult to dress.

Pressure-Tightness of the 88:5:5:2 Alloy

Further evidence will now be given to show that sound castings can be easily obtained in the nickel-bronze alloy. It has already been shown that from the point of view of strength, the 88:5:5:2 alloy seems admirably suited for castings to withstand hydraulic pressure. However, strength alone is insufficient, pressure-tightness being also essential for such applications as valve parts. No difficulty has been experienced in producing castings in the 88:5:5:2 alloy which are pressure-tight. Castings of section as thin as $\frac{1}{4}$ in. have successfully withstood internal water pressure of as high as 1,000 lbs. per sq. in.

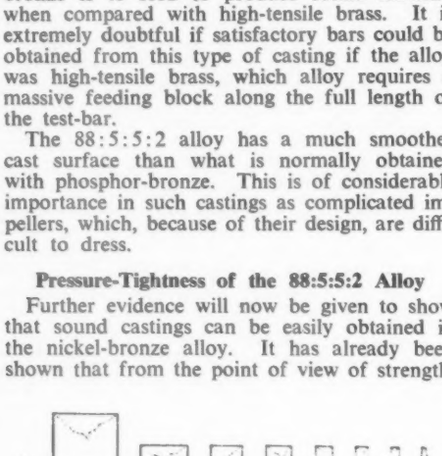


FIG. 2.—POSITION OF SECTIONS EXAMINED.

The view has been expressed that annealing Admiralty gunmetal impairs the pressure-tightness. Castings of the 88:5:5:2 alloy are quite pressure-tight in the "as-cast" condition, and it has been found that in the heat-treated condition the 88:5:5:2 alloy is capable of successfully withstanding considerable water pressure. The following may be taken as typical of the alloy.

A cylindrical sleeve casting was made of 3-in. length by $3\frac{5}{8}$ in. external diameter and $2\frac{3}{8}$ in. internal diameter, giving $\frac{5}{8}$ in. wall thickness. The casting was moulded with the core horizontal; the metal was introduced at one end by a downgate, the ingate being cut at the joint in the mould. In the "as-cast" condition this casting successfully withstood an internal water pressure of 1,450 lbs. per sq. in., the maximum pressure capable of being produced by the testing apparatus. Following this the casting was machined internally to give a wall thickness of $\frac{1}{2}$ in. The machined casting was still pressure-tight at 1,450 lbs. per sq. in. Thereupon the casting was heat-treated for 5 hrs. at 760 deg. C., water quenched, followed by 5 hrs at 350 deg. C. Re-testing of the heat-treated casting showed it still to be pressure-tight at 1,450 lbs. per sq. in. Having successfully withstood this test, the section of the casting was reduced to $\frac{5}{16}$ in. by machining internally and externally, following which it was re-tested. The reduction of section did not in any way affect the pressure-tightness, the casting still being tight at 1,450 lbs. per sq. in.

It is generally recognised that the mechanical properties of test-bars may not be representative of the actual strength of the castings produced. A small tensile test-piece of 0.178 in. dia. in the gauge length was machined from a piece cut from the above casting after completing the pressure tests. The sample had the following mechanical properties:—Brinell hardness (2/40/15), 190; yield, 29.0 tons per sq. in.; tensile strength, 31.5 tons per sq. in.; elongation on $4\sqrt{A}$, 6.

The hardness, yield point, and elongation are as good as those values obtained on test-bars, but the tensile strength is a little lower. When it is remembered that these results were obtained on a bar 0.178 in. dia., machined from the centre of a $\frac{5}{8}$-in. section of the sleeve casting, the results are quite good.

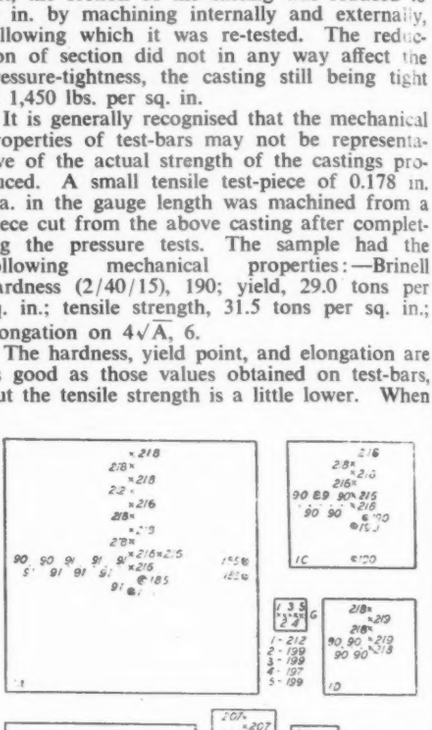


FIG. 3.—BRINELL HARDNESS EXPLORATION RESULTS.

Effect of Mass on Response to Heat-treatment

From experience gained on the response of carbon steel to heat-treatment, it might be thought that difficulty will be encountered in obtaining hardening throughout heavy sections of the nickel-bronze. As the following experiments will show, this is not the case, and sections of up to at least 4 in. can be successfully hardened by heat-treatment.

Eight castings of the following dimensions were made:—(*a*) $\frac{1}{4}$ in. by $\frac{1}{4}$ in. by 6 in.; (*b*) $\frac{1}{2}$ in. by $\frac{1}{2}$ in. by 6 in.; (*c*) $\frac{3}{4}$ in. by $\frac{3}{4}$ in. by 6 in.; (*d*) 1 in. by 1 in. by 6 in.; (*e*) $1\frac{1}{2}$ in. by $1\frac{1}{2}$ in. by 6 in.; (*f*) 2 in. by 2 in. by 6 in.; (*g*) 3 in. by 3 in. by 6 in.; and (*h*) 4 in. by 4 in. by 8 in.

These blocks were moulded with their longest dimensions in the vertical plane. Pieces were cut from the bottom of the four smallest castings to give $\frac{1}{4}$ in., $\frac{1}{2}$ in., $\frac{3}{4}$ in. and 1 in. cubes. Two slices were cut from the bottom of the four largest castings, each slice being half the thickness of the casting. The bottom faces of the four largest castings were polished and a Brinell hardness exploration made across the section. The two slices cut from each casting

were then welded to form a cube in such a way that the bottom face of the casting became the inner face of the cube.

The eight cubes were heated for 5 hrs. at 760 deg. C., water-quenched, followed by 5 hrs. at 350 deg. C., and again water-quenched. After heat-treatment, the four smaller cubes were sectioned, while the four welded cubes were split at the welds. An exposed face from the centre of each cube was polished and a Brinell hardness exploration was made across the section. In the case of the welded cubes, the faces polished were those which had already been explored for hardness in the "as-cast" condition.

Fig. 2 shows the position of the section examined in relation to the castings. Fig. 3 records the result of hardness exploration in each of the blocks. In the case of the four smaller cubes, only the full heat-treated values are given, since the cubes were not sectioned until the heat-treatment was completed. The "as-cast" as well as the fully heat-treated hardness is given for the four larger cubes. It will be evident from these results that mass is not detrimental to the response to heat-treatment. Sections at least up to 4 in. can be successfully treated.

Modification of Heat-treatment

While the heat-treatment process which has already been discussed presents no great difficulty, some even simpler modifications have been developed. For many applications the maximum properties capable of being developed in the alloy are not required. Where this is so, the high-temperature treatment can be dispensed with, the alloy being directly aged in the "as-cast" condition. For example, the following worth-while properties can be obtained by simply treating the "as-cast" nickel-bronze for 5 hrs. at 350 deg. C.:—Brinell hardness (2/40/15), 112; proportionality limit, 10 tons per sq. in.; yield, ½ per cent. elongation under load, 14.2 tons per sq. in.; tensile strength, 25.6 tons per sq. in.; and elongation on 2 in., 30.0 per cent.

By this treatment the alloy is as hard as the phosphor-bronze, has a higher tensile strength, and about 1½ times the limit of proportionality and the yield point.

While the strength of the alloy at 760 deg. C. is adequate to permit of safe handling of most types of castings at that temperature, it is possible that, as a result of the shape or the size, or for some other reason, it would not be advisable to quench a particular casting from 760 deg. C. Cooling in air from 760 deg. C. followed by ageing at 350 deg. C. could easily be done. The rate of cooling of a casting in air depends on the mass and the section. To give some idea of what is likely to be obtained by air-cooling from 760 deg. C. castings of various section, the following experiment was conducted.

As a simple method of obtaining various rates of cooling from 760 deg. C., seven nickel bars, varying in length from 6 to 1½ in. and in diameter from 6 to 1½ in., were obtained, and a hole drilled into the centre of each. A loosely fitting nickel plug was made for each hole, the depth of the hole and the length of the plug being such that a ¾ in. cube could be placed in the centre of each block.

The blocks were heated to a temperature of 760 deg. C. when a ¾-in. cube of the 88:5:5:2 alloy was placed in each hole, followed by the appropriate nickel plug. After 5 hrs. at 760 deg. C., all the blocks were removed from the furnace and cooled in still air. At a later date the rate of cooling of each block was determined.

Following the cooling in the blocks, the ¾-in. cubes were given a 5-hr. treatment at 350 deg. C. The hardness of the cubes and their rate of cooling from 760 deg. C. are given in Table IV. It is obvious from these results that a very useful degree of hardness, namely, 140 to 145 Brinell, can be obtained by moderately slow cooling from 760 deg. C., followed by ageing.

TABLE IV.—*Effect of Various Rates of Cooling from 760 deg. C. on the Response of the 88 : 5 : 5 : 2 Nickel-Bronze to Ageing at 350 deg. C.*

Method of cooling.	Average cooling rate from 760 to 250 deg. C. Deg. per sec.	Hardness after slow cooling from 760 deg. C. + 5 hours at 350 deg. C.
In nickel block 6 in. dia. × 6 in. long in still air ..	0.10	147
In nickel block 4½ in. dia. by 4½ in. long in still air	0.20	139
In nickel block 3 in. dia. by 3 in. long in still air ..	0.29	137
In nickel block 2 in. dia. by 3 in. long in still air ..	0.47	143
In nickel block 2 in. dia. by 2 in. long in still air ..	0.55	143
In nickel block 1½ in. dia. by 3 in. long in still air ..	0.63	145
In nickel block 1½ in. dia. by 1½ in. long in still air	0.77	159

While it may not be possible to handle some types of casting at 760 deg. C., these castings could probably be handled safely at a lower temperature. With this in mind, a further modification in the heat-treatment was developed. In this treatment the casting is given a certain time at 760 deg. C., cooled in the furnace to a lower temperature, and then quenched. Following this the usual ageing treatment is applied. The following is an example of the excellent results which can be obtained by this type of treatment:—Treatment, 5 hrs. 760 deg. C., F.C. to 550 deg. C., W.Q., + 5 hrs. 350 deg. C., W.Q.; Brinell hardness (2/40/15), 191; proportionality limit, 22.4 tons per sq. in.; yield, ½ per cent. elongation under load, 30.0 tons per sq. in.; tensile strength, 37.2 tons per sq. in.; elongation on 2 in., 5 per cent.; Izod, 9 ft.-lbs.

Bearing Characteristics

A necessary feature of any bearing alloy is the ability to resist deformation under compression. In the heat-treated condition the nickel-bronze is capable of withstanding extremely high loads under compression without suffering permanent deformation. Fig. 4 shows a series

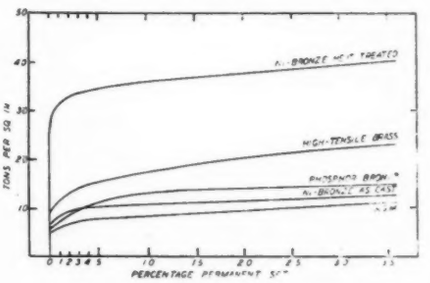


FIG. 4.—COMPRESSION RESULTS.

of curves which illustrate the behaviour of the nickel-bronze alloy "as-cast" and after heat-treatment, as compared with Admiralty gunmetal, phosphor-bronze and high-tensile brass. The heat-treatment applied in this case was 5 hrs. at 760 deg. C., water quenched, + 5 hrs. at 300 deg. C., water quenched. The compositions of the Admiralty gunmetal, phosphor-bronze and high-tensile brass are given in Tables III and V. It will be noted that in the case of the Admiralty gunmetal permanent deformation takes place when loads over 5 tons per sq. in. are applied. This is raised to 6 tons for the phosphor-bronze and 9 tons for the high-tensile brass. In the "as-cast" condition the nickel-bronze requires a load greater than 7 tons per sq. in. to produce permanent deformation, and this is raised to the high figure of 27 tons per sq. in. when the alloy is heat-treated.

The actual assessing of the bearing characteristics of an alloy is not too easy. While laboratory tests may give an indication of how an alloy is likely to behave, the actual quantitative value obtained only holds good for the conditions under which the tests are conducted. The real test of an alloy's suitability for a particular application is best obtained by trial in the particular piece of machinery. With respect to the bearing characteristics of the 88:5:5:2 nickel-bronze, insufficient data are available for definite conclusions to be drawn. For the past nine months a centrifugal water pump has been working continuously with heat-treated nickel-bronze bearings, and no trouble has been experienced. Recently the main bearings of an air compressor at the author's laboratory were replaced with bearings of heat-treated nickel-bronze, and up to now have been working

TABLE V.—*Rates of Loss in Weight of Alloys in Tap Water and Sea Water.*

Alloy.	Loss of weight after 4 days' immersion.	
	Tap water at 16–18 deg. C. constantly changed.	Aerated sea water at 16–18 deg. C. Specimen moving at 2.7 ft./sec.
	Rate of loss, M.D.D.	Rate of loss, M.D.D.
Nickel-bronze (87.53 Cu, 5.22 Sn, trace Pb, 5.02 Ni, 0.035 per cent. P, balance Zn) ..	0.35	72.0
Admiralty gunmetal (87.82 Cu, 10.04 Sn, 0.34 per cent. Pb and balance Zn)	0.26	100.7
Phosphor-bronze (88.25 Cu, 10.80 Sn, 0.08 Pb and 0.65 per cent. P)	0.22	71.0

satisfactorily. While these examples are few in number, they at least indicate that the alloy might have useful properties as a bearing material.

For many applications in shipbuilding, castings have to work in contact with fresh water and sea water. Admiralty gunmetal and phosphor-bronze are well known for their resistance to these media. Table V gives the rate of loss of the nickel-bronze, Admiralty gunmetal, and phosphor-bronze in sea water and Birmingham tap water. Nickel-bronze compares favourably with the other two alloys.

REFERENCES.

[1] Price, W. B., Grant, C. T. and Phillips, A. J., "Alpha Phase Boundary of the Copper-Nickel-Tin System," Trans. Amer. Inst. Min. Met. Eng., 1928, LXXVIII, 511-514. (See also discussion of this paper by E. M. Wise, *ib'd.*, 514-517.)

[2] Wise, E. M. and Eash, J. T., "Strength and Ageing Characteristics of the Nickel Bronzes," Amer. Inst. Min. Met. Eng., Tech. Publn. No. 523. Trans. Amer. Inst. Min. Met. Eng., 1934, CXI, 218-242.

[3] Fetz, E., "Hardenable Copper-Nickel-Tin-Bronzes. I. Relation between Rate of Quenching, Super-Saturation and Mechanism of Hardening." "Giesserei," 1935, XXII, 604-611. "II. Wrought Alloys," "Metallwirtschaft," 1936, XV, 167-170, 189-191. "IV. Influence of Precipitation-Hardening on Resistance to Corrosion," "Korr. u. Metallschutz," 1935, XI, 100-107. "V. Sand-cast Alloys," "Korr. u. Metallschutz," 1935, XI, 219-229. "VI. Combined Effect of Cold-Hardening and Precipitation-Hardening," "Zeitsch. Physik.," 1935, XCVII, 690-698. "VII. Retention of Hardness after Exposure to Raised Temperature Conditions," "Zeitsch. Metallkunde," 1936, XXVIII, 350-353.

[4] Eash, J.T., and Upthegrove, C., "Copper-Rich Alloys of the Copper-Nickel-Tin System," Trans. Amer. Inst. Min. Met. Eng., 1933, CIV, 221-249.

[5] Veszelka, J., "Investigations on the Equilibrium Relationships of Richly Alloyed Bronzes.—I. Studies on the Copper-Nickel-Tin System," Mitt. Berg. Hütten. Abt. Klg. Ung., Hochsch. Berg. Forstwesen, 1932, IV, 162-203.

[6] Kihlgren, T. E., "Production and Properties of Age-Hardenable 5 per cent. Nickel-Bronze Castings," Trans. A.F.A., 1938, XLVI, 41-59.

The Temperaments of Melting Units*

By J. BLAKISTON

The object of this Paper is to give a few details of some melting units together with their peculiarities, of which the author has had personal experience, in order that a discussion may be provoked during which members could compare their experiences and so arrive at a conclusion whether design of unit or operating practice was correct or at fault in the author's or their own individual cases.

In collecting the following information, the personal experience of the operation of twenty-four different cupolas, three rotary furnaces, four batteries of pit fires and three air furnaces has been taken as a basis for the information. It is proposed to describe certain of these units in detail and enlarge on what has been found to be important operation points. Other types of unit may be passed over very lightly and only some particular incident in their operation be touched upon.

The Air Furnace

Though this is a very old method of melting metal, it is still used for the production of certain large castings, namely, rolls, mill housings, etc., and more so for the production of certain large castings of non-ferrous metal such as propellers, marine castings, bells, etc. The air furnace still has the following advantages over other melting units:—(1) A large tonnage of metal is ready for tapping in bulk; (2) large pieces of scrap can be used, reducing breaking-up expenses; (3) very little contamination, particularly in respect of sulphur during melting; (4) a sample may be taken before tapping and the charge adjusted as required; and (5) low-carbon irons can be readily obtained. Probably on account of this the iron melted in an air furnace has always been looked upon as stronger iron than that melted in a cupola.

The following are the disadvantages:—(1) High fuel consumption (approximately 10 cwts. of bituminous coal per ton of metal melted); and (2) skilled labour required for operating.

In a typical 20-ton air furnace, a portion of the roof is detachable so that large pieces of scrap weighing up to 3 tons can be lowered into it by a crane. When the furnace is charged the scrap and pig-iron are stacked tight to the roof so that the heat is drawn in between the various pieces, thus reducing melting time. The successful operation of the furnace depends upon the following points:—(*a*) Regular quality of first-grade, low-ash, high-volatile coal should be used; (*b*) good chimney draught in excess of that which is required for regular working; (*c*) regular firing; (*d*) condition of furnace bottom; and (*e*) absence of air leaks.

The following are a few points in operation: An inferior coal will quickly clinker the bars and so check the draught and combustion necessary for quick melting. Once or twice during the melt, the firebars, which are made of 2-in. square billets, are turned by means of a square key to keep the fire bottom clear. Then there is the necessity for a surplus chimney draught, which can be checked. This is in order that atmospheric conditions can be allowed for. Coupled with this is the need for regular firing and absence of air leaks.

Fig. 1 shows a temperature chart taken from the chimney base. It will be noted that every time the fire-door is opened a kink is formed in the chart owing to the cold air being drawn into the furnace, but by regular firing a crescendo is obtained until two hours before tapping, when a setback is caused by the furnace door having to be opened for alloy additions and rabbling. It will be readily seen from this chart that any air leaks are causing a serious setback to the furnace efficiency.

Air furnaces working on non-ferrous metals will function quite well with a firebrick bottom, but for ferrous work and where higher temperatures are needed a semi-active bottom is essential. This can be made from silver and sea sand. A layer of about 6 in. should be spread evenly on the furnace bottom; a hard skin is fused on to the top of this by a small firing of the furnace. Afterwards it is sometimes as well to have an iron-refining charge put through before general castings are made. This will further improve the bottom of the furnace.

After 12 to 15 heats the bottom of the furnace becomes sluggish and has to be re-made.

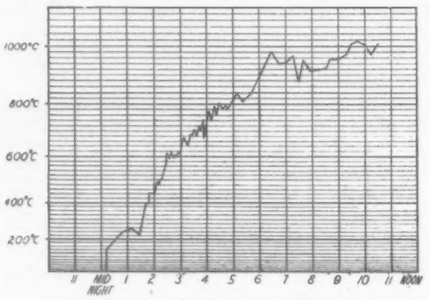


FIG. 1.—AIR-FURNACE CHART.

It is practically impossible to get good results when the furnace is in this condition, as the metal tends to stick to the bottom and great effort has to be made to prevent the bath becoming solid.

Rotary Furnaces

The rotary furnace is an attempt to modernise the old air-furnace practice, but certain extraordinary claims have been made and not fulfilled, which in some instances have created a certain amount of prejudice against this type of unit. The rotary furnace is actually an air furnace which has been constructed so as to rotate, bringing the hot top of the furnace to the bottom, underneath the metal, thus eliminating the necessity of having an active bottom as in air-furnace practice.

Where this is done on a furnace of up to 5 tons capacity, the mechanically moving parts can be kept within reasonable limits, but above this size a large number of mechanical parts and refractory troubles are likely to be encountered, a state of affairs which is to be avoided in all metallurgical practice.

Occasionally, in spite of this rotary motion, metal sometimes builds up on the furnace lining and is only removed with considerable difficulty. An antidote to this is to frit the lining after every heat with a mixture of sand and soda ash. Should the furnace be allowed to become cold with any metal adhering to the lining, this should always be removed before another heat is attempted, or the furnace will gradually build up with a mass of oxidised metal, which is extremely infusible.

Oil is the fuel generally used on small rotary furnaces with considerable success. This fuel is an ideal method of obtaining heat, presenting few difficulties, its only drawback being its cost, which is generally outweighed on small units by its easy handling facilities and cleanliness, reliability and regularity in its operation. Very few troubles are encountered on rotary furnaces with oil as fuel.

With large rotary furnaces pulverised coal is the general heating medium. This method is also being used on large air furnaces with considerable success. When pulverised coal is used as a melting medium, an ash is produced as a product of combustion which tends to lie on the metal and insulate it from further heat. To overcome this a high gas velocity is maintained so that this ash is carried over the metal without settling. As a result of this it can be readily understood that the whole vicinity of the furnace becomes very unpleasant on account of dust, and any electrical equipment is likely to give considerable trouble unless dust-proof.

Pulverised fuel has quite an abrasive and cutting action on refractories, especially in the vicinity of the burner. It is desirable to have all melting units fitted with pulverising equipment, and, together with their pulverising equipment, to have the units situated outside the main building where general operations are carried on.

The moisture content has a vital effect on the behaviour of pulverised fuel, both as regards its heating properties and the subsequent analysis of the metal obtained. This moisture content depends upon the regularity of the supply of fuel and also the humidity of the air.

It is possible to buy coal ready pulverised in containers, to a guaranteed analysis and moisture content, which may mitigate some of the above objections to pulverised fuel firing.

Crucible Furnaces

These furnaces are usually built in batteries of two or more and are generally associated with non-ferrous foundries, but this type of furnace if properly designed will readily melt steel, and forms a useful auxiliary to the cupola for alloy additions in molten form direct into the ladle. This type of furnace may sometimes be used with a forced draught to accelerate melting.

When certain alloys of a readily oxidisable nature are melted, *e.g.*, ferro-chrome, first a bath of ordinary iron should be melted into the crucible bottom, and the alloy dissolved by adding in small pieces. Also the pots should be covered to prevent access of air. The author once found when attempting to melt ferro-chrome that the lumps, without any apparent change in appearance, had, during the heating, become oxidised to chrome oxide, a most infusible metal, but the aforementioned procedure removed any difficulty in subsequent melts.

The pit fire, although small in capacity, rarely gives any trouble, and as long as the grate bars are kept clean and no air leaks are allowed to develop, the furnace will function satisfactorily year in year out.

The Cupola

The melting units which have been considered up to now have all been types where the fuel has been separated from the charge to be melted. The remaining type to be considered, *i.e.*, the cupola, has the heating medium in direct contact with the charge to be melted, and may be classified as a type of its own with its own definite characteristics.

Hundreds of designs have been evolved with various claims as to performance—square cupolas, round cupolas, oval cupolas, tall ones, short ones, pressure-blown, suction-blown, balanced blast, unbalanced blast, auxiliary blast, and a host of other variations which may or may not improve their general efficiency, but it is probably true to say that the best results from the cupola can be obtained by adopting standard and regular practice in operation.

The operation of the cupola can be compared with the manufacture of gunpowder. The correct amount of combustible matter must be present. The correct amount of oxygen to create the combustion must be there, and a required material size to propagate combustion must be in existence. Should these fundamental facts be disregarded trouble is always likely to be met; poor metal in the case of the cupola, and a damp squib in the case of the gunpowder.

(*Concluded on page* 406.)

* Extracted from a Paper read before the West Riding of Yorkshire Branch of the Institute of British Foundrymen, Mr. S. Carter presiding.

Electric Motor Castings in Green Sand

By JOHN HIRD

(*Continued from page* 381.)

Moulding the Ball-Bearing Cover

The moulding boxes are those used for the shell casting split up into suitable depths. In this case, the 6-in. middle part is used for the bottom part. The 4-in. middle part is bolted to the 17-in. top part which has the loose bars in the centre inserted, and forms the top part. The inside of the cover is moulded bottom downwards. The grid shown on the right of

FIG. 12.—MOULD FOR BALL-BEARING COVER.

Fig. 11 was of similar proportion to that used in the shell, but is closed at one end. This is used to get the gas away from the mould quickly and to prevent the cod lifting.

By fixing the ½-in. dia. screwed rod gaggers, used in the first two shells, into holes round the rim of the grid, so that they reach to about 1 in. on the inside of the baffle and extend to within 1 in. of the outside of the pattern, the cod is prevented from being lifted when the metal gets under the baffles during casting. The grid is 13 in. deep, and, as in the shell, the rim makes a metal-to-metal contact with the bottom plate, to which it is bolted.

The sand is rammed into the bottom part to a depth of 7 in., and then struck off level with a strickle from the joint of the box to a depth of 6 in. The grid is then placed in position and tapped down until it is perfectly level with the edge of the box. Sand is now rammed in until it is just above the level of the bottom of the baffle. A strickle is again used to strike the sand off level under the baffle, the loose pieces are placed in position, and the rest of the bottom rammed up. The bottom is struck off level and the bottom plate bedded on and bolted down.

The bottom mould with the loose pieces withdrawn (shown together with the top box in Fig. 12) illustrates the overhang of the cod to form the baffle. A clearance of 3 mm. is allowed between the window opening facing on the cod and the pattern. The bottom mould stands on weights and clears the floor by 6 in., giving ample room for firing the gas when casting, and preventing an explosive mixture collecting under the box.

The top mould is quite straightforward. Two 1½-in. dia. down-runners are placed in each corner on the bottom side of the cover, and ingates are cut into the rim to run round the outside of the cover, missing the windows. Three 1-in. risers are brought off the bearing boss. After the top has been turned over, the runner and riser bushes are made up, and the weight balanced. With this first casting, the top was slung for lowering on with the cross beam and chain slings over the trunnions. Owing to the fact that, so slung, the top can rock on the trunnions, the 3-mm. clearance was insufficient, and the facing was caught during lowering, leaving some loose sand on the top of the windows. This unfortunately was not seen until the casting was knocked out. It was not sufficient to scrap the casting, but to avoid this happening on future castings, the top part is now

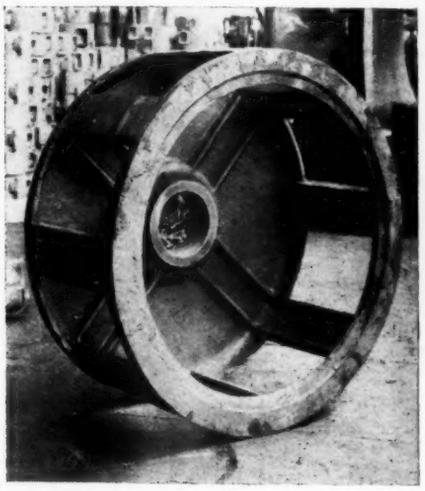


FIG. 13.—DEEP END-COVER CASTING.

slung on the four hook adjustable slings from each corner and the box levelled with a spirit level before lowering over the bottom mould. Closed in this way, the 3-mm. clearance is quite adequate.

The Deep End-Cover Casting

This casting, shown in Fig. 13, is 24 in. deep; it has a general thickness of ⅛ in. and weighs 11 cwts. The openings round the side are for accessibility to the brush gear, and the casting really consists of a flat top and a bearing connected to a rim and baffle by eight ribs, 6 in. wide and 18 in. long.

The same methods were adopted for the making of this cover as for the shallow one—a block pattern mounted on a board for the outside with the core part built up into a frame as is shown in Fig. 14. The clearance through the opening was again 3 mm. The baffle and end of the opening are formed by a loose ring cut into two pieces. The core grid is the same as for the shallow cover, except that it is 24 in. deep.

The overhang of the main core caused by the 4½-in. deep baffle is carried by the gaggers in the core grid, which rests on the bottom plate and is placed in position in the mould by strickling off the sand level and bedding down. The top and bottom moulds for the deep end-cover are shown in Fig. 15. The top moulding box is made up of the 17-in. deep top part, to which is bolted the 4-in. deep part, and followed by the 12-in. deep part, making a 33-in. deep box in all. The 6-in. part is used for the bottom part, and all the boxes are in use with the exception of the 2-ft. square extension box.

It is likely that when the next deep casting is made, the 17-in. deep top part will be used loose, and a joint made across the top of the middle part formed by the 12-in. and 4-in. parts bolted together. This will be done because it is very difficult to ram up the 33-in. top part through the bars in the top and get uniform ramming. On this first casting, the side ribs were swollen and out of shape in one or two places. This did not scrap the casting as the outside of these ribs is machined, to take a band which covers up the openings and protects the brush gear. It is also felt that with this part split it will be easier to handle, although it involves more work.

The runners and risers are the same as were used for the shallow cover, and the same methods are adopted for closing up. The stirrup clamps holding the bottom part to the bottom plate are used so that, after closing up, the 1-in. dia. holding-down bolts can go straight through the holes in the lugs, to the underside

FIG. 14.—PATTERNS FOR DEEP END-COVER CASTING.

of the bottom plate, without releasing the bottom plate from the bottom part, for if there were any spring between the bottom plate and the bottom part it might disturb the mould.

Sleeve Bearing for Deep and Shallow Covers

These are for taking white-metal self-aligning bearings. They are referred to in the foundry as sleeve bearings; to call them plain bearings, in view of their complicated nature, and the simplicity of the ball-bearing boss, led to confusion. The moulding boxes are the same as for the ball bearing with the exception of the top part. The loose bars in the middle of the top part are removed, and two pins are fitted in two of the four holes provided in the fixed bars, and two ½-in. bolts are put in the two remaining holes for bolting down. A joint is made across the top of the box, as the bearing part of the pattern projects up above the top of the box, and the 2-ft. square, 12-in. deep extension box is used for moulding this projecting part. It is located on the pins and is used for two reasons; first and most important, had a further section been made deep enough to take the bearing extension, that is the full size of the box, the crane would have been overloaded when making the deep cover. Secondly, this method saved a considerable amount of ramming-up work.

The inside of the bearing is formed by three oil-bonded sea-sand cores, and its assembly is shown in Fig. 16. The cores are bolted down on to the grid and do not rely on the prints in the top part to hold them in position. The distance between the bottom of the print, and the top of the grid in the bottom part, is filled in with a block of iron, when ramming up the bottom part. This has a hole through the centre and a ½-in. dia. rod with a nut on the end is threaded through this hole and a corresponding hole in the top of the grid. This rod is put through the bottom core, which rests on the block of iron at the bottom of the print. This core forms the one side of the

bearing below the self-aligning pedestal, and half of the oil reservoir. The second core is placed by the side of this, and forms the grooves in the edge of the bearing for returning the oil to the reservoir. This core is bolted horizontally across to the first core. The third core which forms the other half of the bearing and the oil reservoir above the self-aligning pedestal has two sumps extending below the reservoirs for draining out the oil. These protrusions on the core which form the two sumps prevent the top part from passing over the core, and the top part is now lowered on without the extension box. The third core which locates over the first core is placed in position with the ½-in. dia. rod threaded through it, and then screwed down with a nut on top. This holds the whole assembly firmly fastened down on to the top of the grid and independent of the prints in the top part maintaining its position.

The extension box is lowered on and bolted down. As the metal thickness of the sleeve bearing extension is only ⅜ in., two ½-in. dia. risers are all that can be brought off. The gas is brought through a hole running parallel with the ½-in. dia. rod hole through cores (No. 1 and No. 3, Fig. 16), the top of the print in the extension box is cut away, and a tube placed over the vent, and the sand rammed round it. The gas is brought away from core No. 3, independently, in an exactly similar manner. The runner is built up to ensure there being a good head of metal above the part of the casting in the extension box. All these castings were made in the iron usually used in the foundry, which has an analysis of T.C, 3.16; Si, 2.38; Mn, 0.5; S, 0.09; and P, 1.0 per cent., and has a tensile strength of 14 tons per sq. in.

FIG. 15.—TOP AND BOTTOM MOULDS FOR DEEP END-COVER.

Facing Sand.—The same mixture of sand is used for both core and mould, on the shell, and also on the end covers. It has a permeability of 33 and a green compression strength of 27 lbs. on a 2 in. dia. test-piece, and is used at a moisture content of 4½ per cent. Sand is mixed in an August Simpson mill, with an aerator attachment, and is then put through a Royer disintegrator. The sand mixture is 50 per cent. returned black sand and 50 per cent. milled red sand, to which is added 12½ per cent. by weight of coal dust. The moulds and core are brushed over with dry plumbago, which is then well rubbed in by hand.

In conclusion, the author wishes to express his thanks and appreciation to Higgs Motors, Limited, for giving him permission to present this Paper, and particularly to thank the works manager, Mr. Patchett, for the practical assistance he has given in preparing the photographs.

DISCUSSION

The CHAIRMAN (Mr. A. Tipper, M.Sc.) thought some members would have comments to make concerning the 12 per cent. of coal dust used in the sand mixture.

MR. B. HIRD expressed the opinion that for a job of that size moulded in green sand, 12 per cent. of coal dust by weight would be all right. That, however, was not quite the same as 12 per cent. by measure, which was adopted in most foundries.

MR. J. HIRD explained that, roughly expressed in volume, the mixture consisted of one and a half barrowfuls of red sand, one and a half barrowfuls of black sand, and four bucketfuls of coal dust.

MR. B. HIRD replied that when the Sand Sub-Committee of the Technical Committee of the Institute of British Foundrymen sent out a *questionnaire*, one of the most amazing things was the great variation in the amount of coal dust used. Except from the point of view of economy, light work needed a smaller percentage of coal dust than heavy work. The figures varied from 1 to 30 or 40 per cent., but the quality of the coal dust must be taken into consideration. He wished to pay a compliment to the lecturer, as to make such a job in green sand was certainly a plucky and well-thought-out effort. He thought 75 per cent. of them would never have tackled the job in green sand. The experience gained in regard to contraction with green sand would doubtless save others from the same pitfall.

MR. J. HIRD explained that the reason he used so much coal dust was on account of the large percentage of red sand in the mixture.

Another MEMBER suggested that it might have been possible with the larger castings to have made a segment core of one-fifth of a circle with the splits on the ribs, and a quarter core for the end covers. That would have saved expense on patterns, etc.

MR. J. HIRD replied that the difficulty would have been to get the segments to clear the top of the window openings, and also to get the end covers symmetrical with the shell. His firm were prepared to spend money in order to make a good job.

The CHAIRMAN remarked that he had expected the question of contraction and distortion to be raised. That seemed to him to be one of the important problems in a casting of that type. He presumed that the degree of accuracy required was of a high order, and for that reason the tackle was well designed rather than built haphazardly. It was a big undertaking, and he wondered how long it took from the making of the first plan to the making of the first satisfactory casting.

MR. HIRD replied that it was about eleven months since they received the order, and two complete motors were now going through the works. So far as the shell was concerned, about three months passed from the time the drawings were received to the first good casting being finished. Of course, the question revolved about the number of men working in the patternshop, and they had to work upon it in conjunction with more urgent jobs.

MR. J. J. SHEEHAN remarked that he liked the mechanical ingenuity displayed in the foundry as described by Mr. Hird. In his opinion, the pouring of that weight of metal over green sand was an achievement. He agreed that running the metal in at various points helped considerably, and also assisted from the point of view of distortion.

MR. HIRD said he used four running-in points in order to keep the casting symmetrical. He was afraid of the core lifting and the metal getting out of the bottom of the print. To prevent this, they used oil and plumbago where metal to metal contact took place. The core grids were machined to $\frac{1}{64}$ in., and they worked as accurately as possible throughout. That, he thought, was the reason why they were successful.

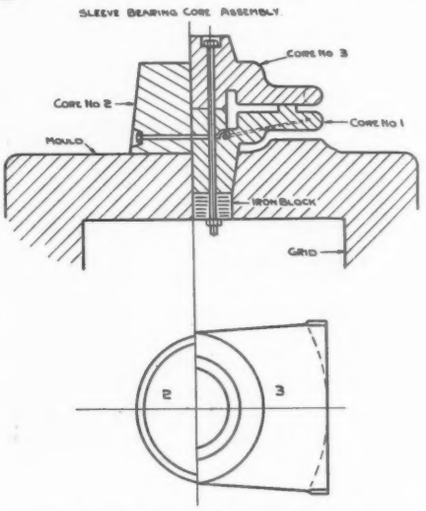


FIG. 16.—CORING METHOD USED FOR THE INSIDE OF THE BEARING.

Vote of Thanks

On the proposition of MR. F. J. COOK, seconded by MR. T. H. GAMESON, Mr. Hird was heartily thanked for his Paper. MR. COOK remarked that it was often said the Institute did not have enough practical Papers, but the one given that night should satisfy anyone from that point of view. It required considerable ingenuity and pluck for a young man to face a job of the sort described, and he congratulated him upon the way he played for safety.

MR. HIRD suitably acknowledged the vote of thanks.

A National Savings Week

The National Savings Committee is organising a National Savings Week from June 9 to June 15. The object is not so much to raise a large sum of new money during the week, but to increase the number of Savings Groups. Of these there are already over 80,000. By June 15 it is hoped to achieve at least 100,000. Closely allied to this main object is the desire to increase the membership of existing groups and to increase the amounts of the weekly subscriptions to them paid by members. Of the Savings Groups formed since last November, 75 per cent. are in places of employment. The action of the Government in exempting from various Means Tests £375 worth of new savings has drawn from the Trade Union Congress a declaration and a broadcast urging all trade unionists to support the voluntary savings movement. Organised employers have given assurances that proof of the workers' capacity to save shall not prejudice future wage negotiations. It is hoped that these assurances will result in a strong stimulation of savings groups in all industries and trades. Employers who have not yet formed groups or given facilities for their formation should place themselves in touch with the National Savings Committee, Sanctuary Buildings, 20, Great Smith Street, Westminster, S.W.1.

Application of Cast Iron in Modern Automobile Construction*

By E. C. TOGHILL and R. V. DOWLE

(*Continued from page* 384.)

COMMON APPLICATIONS IN AUTOMOBILE CONSTRUCTION

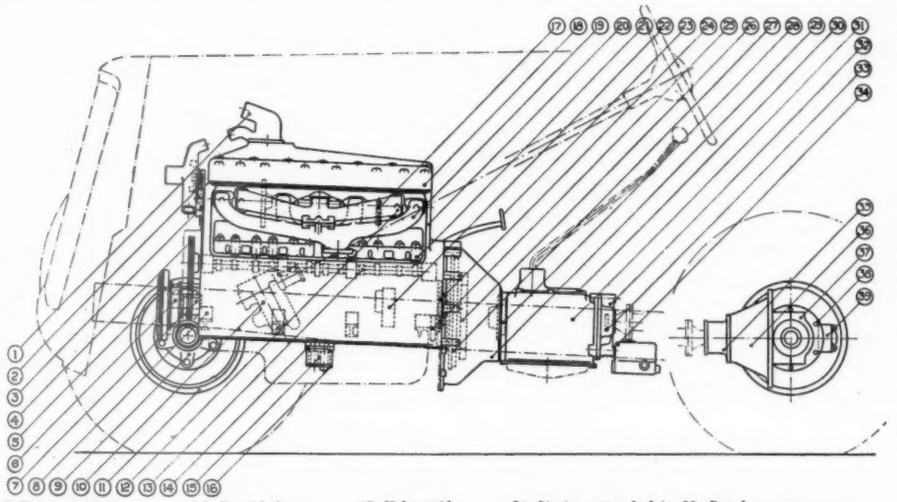
In the following paragraphs are mentioned some of the larger components of the motor-car chassis which are commonly produced and used in a cast iron of one or another of the various specifications. It is a very fair statement that one or more of these components (or sets of components) will be found on every chassis in production, and every one of the cars of the popular quantity-produced class has a total of from forty to fifty parts made in cast iron.

The component responsible for the greatest output tonnage is undoubtedly the cylinder block. It is now very common for this to be made in one with the top half of the crank-case, and this results in the stiff structure which is very beneficial in minimising bore wear. In the case of commercial vehicles, the life of which often has to be extended for hundreds of thousands of miles, it is quite usual to employ separate replaceable cylinder liners, either wet or dry.

Cylinder heads are the next in importance on the weight production list, and in the case of the overhead-valve engine this is a very considerable proportion, although offset by a lighter cylinder block.

Bell housings and gearboxes are usually in one piece, and are commonly used in cast iron, as also are the axle casing and bevel pinion housing. Cast iron is practically of universal adoption for brake drums in car and commercial vehicles, even on the smaller cheap cars. Induction pipes and exhaust manifolds are used in cast iron and the various flanges employed in the exhaust system. Flywheels and clutch presser plates are extensively used in this material, and are replacing steel for their respective functions in no uncertain fashion.

Cast camshafts are being produced in ever-increasing quantities and are showing their advantages in the saving of machining and hardening costs, and particularly the abolition of tappet troubles. Steering boxes are extensively used in cast iron by the various producers of the complete units, and also the master cylinders and wheel cylinders of hydraulic braking systems. Crankshafts are the subject of experimental work by a large number of car manufacturers and are showing promising results, but production on a large scale has not yet been attempted, except, of course, in the case of Ford Motor Company, and although metallurgically a cast iron, this material is considered by the foundryman to be in the steel range, since it is similar in its "casting" characteristics.



1. Thermostat body.
2. Water pump impeller.
3. Water pump body.
4. Camshaft chain wheel.
5. Crankshaft damper ring.
6. Crankshaft damper pulley.
7. Crankshaft chain wheel.
8. Main bearing cap.
9. Front hub.
10. Steering box.
11. Brake drum.
12. Induction manifold.
13. Camshaft.
14. Oil pump body.
15. Oil pump gears.
16. Oil pump cover.
17. Valve guide.
18. Cylinder head.
19. Exhaust manifold.
20. Cylinder block.
21. Valve tappet.
22. Starter front end cover.
23. Clutch pedal.
24. Starter rear end plate.
25. Rear main bearing.
26. Clutch pressure plate.
27. Flywheel.
28. Gear-box front cover.
29. Clutch housings.
30. Gear-box top cover.
31. Gear-box casing.
32. Gear-box rear cover.
33. Speedometer pinion.
34. Hydraulic brake master cylinder.
35. Pinion housing.
36. Rear axle casing.
37. Axle casing cap.
38. Rear hub.
39. Hydraulic brake wheel cylinder.

FIG. 1.—DISPOSITION OF CAST-IRON COMPONENTS.

A fairly comprehensive list of parts is given in conjunction with Fig. 1, which illustrates the various applications. This shows clearly the disposition of the greater proportion of the cast iron components in a typical modern private-car chassis. The drawing is a composite one and includes practically all the major cast-iron parts which may be found in present-day productions and the list given forms a key to the numbers shown in the drawing.

There are other small items which are not shown, but which are usually produced in cast iron, such as valve seat inserts, piston rings, crankshaft balance weights, engine support brackets, distributor bodies, various bushes, shock-absorber bodies, etc. In commercial vehicle practice also it is usual to find some components produced in cast iron which are generally made of other materials in private-car design. These include dumb irons, spring hangers, spring bolt pads, propeller-shaft centre bearing brackets, engine support brackets, pistons, etc.

It may be of interest to give some idea of the actual proportion of cast iron used in modern chassis construction, and two examples of large-quantity production 10 h.p. cars have been analysed in detail, one of the overhead valve design and the other of side valve design. For comparison there is also the figure obtained with a 14 h.p. chassis, a 20 h.p. chassis, and a large-quantity production truck (5-tonner), and these proportions are all shown in Table II.

TABLE II.—*Consumption of Iron Castings in Motor Vehicle Construction.*

Chassis.	Proportion of cast iron by weight. Per cent.
10 h.p., O.H.V.	19.1
10 h.p., S.V.	15.4
14 h.p., O.H.V.	23.5
20 h.p., S.V.	22.4
5-ton truck	21.0

The above estimates have all been obtained from English vehicles, and no attempt has been made to ascertain the proportion of cast iron in American vehicles; but it is believed that this would be found to be greater than in English practice, the Americans being well known to favour cast iron in their production.

The latest development in cast-iron production for automobile components is for camshafts and crankshafts, and these components, therefore, are worthy of special mention in this Paper.

Camshafts

Cast-iron alloy camshafts are a very interesting recent development in this country, but were successfully employed in the States some time before their advent in England. The word "recent" is used advisedly, as in actual fact several years were spent in experimental work by the company with which the authors are associated, until the most suitable grade of material was found and the best method chosen for obtaining the hardened cam tips and the correct hardness of material for maximum wear properties.

One of the problems was that of assuring reasonable life for the gear driving the oil pump and distributor, which in many engine designs is made as an integral part of the camshaft. This is usually a spiral gear with a right-angle drive and the mating gear on the oil-pump shaft is made more often than not from a case-hardened steel. Lengthy tests were carried out on three pairs of spiral gears, all having fifteen teeth of 14 D.P. and 20 deg. pressure angle with a 45 deg. spiral angle. Each of the pairs of gears drove an orthodox oil pump at 1,500 r.p.m., and in each case the driving gear was of "Monikrom" (a nickel-chromium-molybdenum cast iron) camshaft alloy, while the gears on the oil-pump shafts were (*a*) case-hardened steel, (*b*) phosphor-bronze, and (*c*) "Monikrom," respectively. This test was carried out for a twofold purpose: (1) to find the rate of wear under normal conditions, and (2) to compare the wear with the three different materials mentioned, which are commonly used in the mating gears.

The curve illustrated in Fig. 2 shows the result of the test which was carried up to 3,500 hrs. or the equivalent of 175,000 miles on the road, and it clearly shows that the alloy used is extremely good for wear and that it is immaterial whether case-hardened steel, phosphor-bronze, or similar iron is used for the mating gear, given normal operating conditions.

It is interesting to note that many types of camshafts are now produced in this alloy for a number of manufacturers and rapidly increasing production shows that the cast camshaft is fast becoming accepted as a proved component and one which has several inherent advantages over that of case-hardened steel.

Crankshafts

The cast-iron crankshaft has not been considered very seriously in the past owing chiefly to the very low tensile strength formerly

* Extracts from a Paper presented to the Institution of Automobile Engineers.

obtained in the material. The development of high-duty alloys, however, has led to a re-awakening of interest in this direction, and a considerable amount of experimental work has been done by several manufacturers who are looking toward the possibilities of this material. Particular interest is shown in the larger shafts, where the possible saving of weight is considerable, and the advantage of being able to incorporate bob weights so that shafts may be completely balanced is viewed with favour.

Cast iron as a shaft material has several inherent advantages which make it eminently suitable, the chief of these being its well-known good bearing properties and excellent wear characteristics and its capacity for damping internally any vibrations which are set up by external forces.

Advantage may also be taken of the cast component to incorpate hollow spaces in the pins and journals and webs of such a shape to result in the even distribution of stresses throughout the whole length of the shaft and thus to increase the fatigue resistance. This is being carefully examined by certain manufacturers, and the progress of the investigations will, no doubt, be followed with great interest by designers, particularly those of compression-ignition engines, in whose field the scheme is likely to be most advantageous.

Cast-Iron Gears for Auxiliary Drives

Gears of cast iron for auxiliary drives have always been very popular, and now that roller chains have largely replaced gears for this purpose, particularly in car design, it is common practice to use a cast-iron alloy for the chain wheels themselves. When spur or helical gears have been designed in cast iron it has been the usual practice to employ the formula put forward in British Standard Specification No. 436/1932, and this includes the factors for bending stress and surface crushing for the common grade of iron produced for general engineering purposes, namely, a coarse graphitic iron of about 10 tons per sq. in. tensile and 150 Brinell.

TABLE III.—*Basic Bending Stress Factor and Basic Surface Stress Factor for Spur Gears.*

Grade of iron.	Surface crushing. Sc.	Bending. Sb.
Malleable	800	11,000
Ordinary	1,000	6,000
Medium	1,350	7,600
High-grade	1,450	10,000
"Monikrom"	1,750	10,000
High-grade heat-treated ..	2,000	10,000

With the development of the high-grade alloy irons such as specified in B.S. Specification No. 821/1938 these figures were unsuitable for the increased loads allowable with these alloys. David Brown & Sons, Limited, of Huddersfield, have recently carried out extensive research to obtain the corresponding factors both for spur and also spiral gears in cast-iron alloys, which would give the allowable loading on the teeth for safe maximum power transmission for the four grades of iron specified, namely (1) common, (2) medium, (3) high-grade, and (4) high-grade heat-treated, and they have completed the investigation of spur gears with the results as shown in Table III.

The work on spiral gears is still being executed, but the authors are allowed to give the results so far obtained. It will be appreciated that the investigation on allowable loads for spiral gears is quite original, and as it is believed that there are no earlier data for comparison, these figures should be looked upon as extremely tentative until the whole of the work is completed. This, as can well be imagined, will take some considerable time. The results up to date on the spiral gears are shown in Table IV. It is interesting to note that the results include figures obtained from spiral gears of "Monikrom," and that it was the excellent behaviour of this material in cast camshafts which led to the decision that more scientific knowledge was desirable, so that full use of the improved characteristics obtained in the higher grades of cast ferrous alloys could be made for other gear applications.

Co-operation between Foundry Executives and Chassis Manufacturers

There has been a very marked tendency in the last few years for chassis manufacturers, usually in the person of the chief engineer or designer, to consult the foundry when a new design is materialising in the drawing-office. This co-operation is to be heartily commended, since it is during this period that possible trouble in future production, both in the foundry and in the motor factory, can be prevented. It is gradually being appreciated among engineers that foundries that have specialised in the production of motor-car components for many years have accumulated funds of knowledge that are of value to the designer.

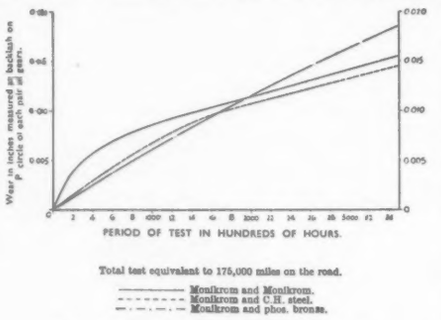

PERIOD OF TEST IN HUNDREDS OF HOURS.
Total test equivalent to 175,000 miles on the road.
Monikrom and Monikrom.
Monikrom and C.H. steel.
Monikrom and phos. bronze.

FIG. 2.—GEAR WEAR TEST RESULTS.

Those designers who consult foundry executives (recognised as authorities in their particular sphere) are surprised at their knowledge of design requirements for cylinder blocks and heads, and other important components. This knowledge, culled from past experience, is at the service of the engineer, but it must not be forgotten that for so many years past has the foundry been accused of being the cause of overheating engines, distorted castings and cracks of various kinds in service, that the foundryman is rather a little shy of suggesting that the designer may be wrong. In point of fact, however, quite a large percentage of the so-called foundry troubles met with in the past have had as their basic cause some fundamental in casting design. Some small points, but nevertheless very important ones, which are often overlooked in designing components for production as castings are:—

(1) Extremely thin sand walls (*e.g.*, between cylinder bores or behind valve pockets) should be avoided where possible.

(2) Very sharp corners are sometimes shown where good size fillets would assist in running the metal and in no way detract from the actual design requirements.

(3) Sudden changes in section from thick masses of metal to thin walls, which result in residual casting stresses, should be avoided.

(4) Small core holes of insufficient size, which do not allow adequate inspection of awkward internal shapes for the purpose of assuring absolute cleanliness and extraction of core wires, are to be deplored.

(5) Pockets inside castings which may hold foundry dirt can often, with advantage, be incorporated on the outside.

(6) Large areas of thin metal which are unsupported by any form of ribbing or corrugations should be strengthened up.

It is in such points as these that co-operation is so beneficial and an early interchange of ideas undoubtedly results in the product reaching a satisfactory production in the minimum space of time.

Likely Trend of Development

When consideration is given as to which of the important discoveries in the past have been responsible for the use of cast iron in new fields of application, it is realised that the engineer's requirements at some particular period have very largely guided the direction in which foundry research has been undertaken. It can be truthfully stated that, as with many other lines of development, one discovery leads to another, and it is impossible to say specifically what is the ultimate aim of metallurgical research into cast iron and its alloys.

Probably the one characteristic which is generally felt to be a hindrance to many of the likely applications of the future is the comparative lack of ductility of the grey cast irons, and there is no doubt that the possibility of improvement in this direction is one of the problems for which a solution will be continually sought.

It may be said that this characteristic is already provided in malleable cast iron, and that to a certain extent is true; but, apart from some inherent advantages and disadvantages which the one type of iron may have when compared with the other for any particular application, it is logical to assume that development in the malleable field would be towards cutting down the production time cycle and reducing as far as possible the extraneous equipment and the thermal treatment necessary to obtain the required elongation.

Then again, it is safe to prophesy that endeavour will be made to increase each or any of the individual physical characteristics for which any of the specialised irons is specified.

Last, but by no means least, on the list of importance is the endeavour to obtain irons which will give characteristics equal to present-day standards of acceptance, but at reduced cost; and it is perhaps no exaggeration to say that this usually has a greater appeal for the automobile manufacturer even than has improved qualities. Adoption of new ideas has often seemed a longer process than it need have been. Even when the foundry has spent several years on an investigation that has distinct commercial possibilities and marked technical advantages, it is often several more years before the automobile manufacturer grudgingly consents to try it out.

An outstanding example of this "time-lag" in recent times was the development of the cast-iron brake drum. It took several years for the motor industry to recognise the virtues of alloy cast iron for this particular component, and yet this material is now specified, as a matter of course, in practically every English make of car and commercial vehicle.

TABLE IV.—*Basic Bending Stress and Basic Surface Stress Factors for Spiral Gears.*

Material.	Basic bending stress factor.	Basic surface stress factors when running with "Monikrom."	"40" carbon steel.	3¼ per cent. Ni-Cr-Mo steel.	3½ per cent. Ni C.-H. steel.	Phosphor-bronze.
"Monikrom"	12,000	2,000	2,700	2,000	1,600	5,000
"40" carbon steel	20,000	2,700	—	—	—	—
3¼ per cent. Ni-Cr-Mo ..	30,000	2,000	—	—	—	—
3½ per cent. Ni C.-H. ..	40,000	>1,600	—	—	—	—
Phosphor-bronze	10,000	5,000	—	—	—	—

(*Concluded on page* 406.)

For High Quality Castings

The increasing demand for high-strength close-grained iron castings calls for improved metal. In comparison with the accepted standards of the past, the modern high quality casting requires lower total carbon and phosphorus, with a closer range in silicon. The Ironfounder can now meet this demand at a reasonable cost by the use of Stanton-Dale Refined Pig Iron.

Stanton-Dale is a pig iron of low total carbon, the graphitic carbon being uniformly distributed and of fine curly-flake formation. The close structure ensures remarkably high strength with good machineability, and Tensiles of 16 to 20 tons can readily be obtained when a proportion of Stanton-Dale Iron is introduced.

The use of this iron avoids the irregularities in structure which are sometimes observed when steel scrap has formed part of the charge.

The correct grade of Stanton-Dale Iron to use depends on the type and class of castings to be made. The Stanton Technical Service is available to advise on suitable mixtures.

Total Carbon from 2.6 per cent. upwards. *Analysis to individual specification as required.*

STANTON-DALE
REFINED PIG IRON

The Stanton Ironworks Company Limited, Near Nottingham

The Largest Producers of Foundry Pig Iron (for Sale) in Great Britain

Founders' Forum

Q.—Can you detail a method for the successful production of cast-iron blocks 10½ in. dia. by 9 in. deep which have to be machined in the centre?

A.—This problem is not so easy as might be anticipated in such a simple form. In the first place, the metal composition must be correct, with a view to giving a close-grained material throughout this massive section. Even more important is the necessity to provide ample feeding metal in a suitably-designed feeding head, to ensure that porosity due to liquid shrinkage is removed from the area of the casting proper. A suitable composition would be as follows:—T.C, 2.9 to 3.2; Si, 0.8 to 1.0; Mn, 0.7 to 1.0; S, 0.12 (max.); P, 0.30 (max.); Ni, 1.5 to 1.8; and Cr, 0.4 to 0.6 per cent.

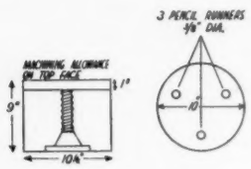


FIG. 1.

Two methods of running and feeding this casting could be used satisfactorily, choice being left to the individual foundry according to facilities available. (1) *Slow running with "pencil" runners on top.* In this method ¼ in. to 1 in. additional machining allowance is put on the top face and three small pencil runners about ⅛ in. dia. are applied to the top face, as shown in Fig. 1. (2) *The alternative method* is to add a complete feeding head equal in height to the casting itself and tapered from 10½ in. dia. at point of junction with the casting to some 16 in. dia. at the top of the head and use top runners (Fig. 2).

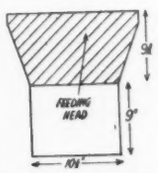


FIG. 2.

It is also of interest to note that certain well-known engineering firms order blanks of this type in the form of "stick" castings, 24 in. to 36 in. long. These are cast with tapered feeding heads as shown above, and the required blanks parted off. The casting represented above appears to be a forming die of some kind. If this assumption be correct, then the recommended composition would be as follows:—T.C, 3.2 to 3.4; Si, 0.8 to 1.2; Mn, 0.7 to 1.0; S, 0.12 (max.); P, 0.20 (max.); Ni, 3.5; and Cr, 0.75 per cent.

Comment.—The foundry sending this query writes:—We do not think the three small runners would be successful, having tried them on similar blanks, not nearly so heavy, which we have successfully cast with the block type runner. It is probable that the composition of the metal is the most important factor, and, combined with the very large head, may produce the desired effect, but we are afraid that the cost both of the casting and additional machining would be prohibitive, where a forged steel blank could or might be obtainable. It is one of those apparently simple jobs that may not, after all, be practicable and economical at one and the same time.

Book Review

Steel Manufacture Simply Explained. By Eric N. Simons and Edwin Gregory. Published by Sir Isaac Pitman & Sons, Limited, Parker Street, Kingsway, London, W.C.2. Price 6s. net.

It is difficult for the reviewer to imagine himself as being completely devoid of knowledge of steel manufacture and to evaluate the book from that angle. However, he is inclined to the view that its main interest will be for those possessing some degree of technical knowledge. Into this class enter the engineering and metallurgical professions allied to those confined to steel manufacture, and this "class" is a very large one. Many of our readers are of this class and they will be able to appreciate its contents to the full. The book is only reasonably well balanced, for both rolling mill and forge practice are omitted, except in connection with the manufacture of tool steel.

Too much space (two chapters) has been devoted to the production of blister and shear steel, for in truth it is as the authors describe it, "this old-time process," yet it is perhaps the best description of the processes recently made available. In dealing with each of the processes except the high-frequency furnace and the open-hearth system, historical notes have been included. Indeed, in the case of the Tropenas method a historical document drawn up by the inventor has been used as a description of the process. This is a very valuable inclusion for it will make the book useful in future historical research. The penultimate chapter (XX) is devoted to steel castings and the reviewer takes exception to the somewhat loose phrase: "Patterns are made from blue prints supplied by the customer," as it is not unusual to receive the actual patterns from the customer. The practice described is typical of the Sheffield foundries but not necessarily so of the whole industry.

The 38 illustrations have been well chosen, but a few have not reproduced any too well. There are 21 chapters, ten of which are devoted to steel melting processes, whilst the transformation of iron ore to pig-iron, the shear steel process, the steel foundry and refractories constitute the balance. For anyone in the field defined, the reading of this book will be both interesting and instructive.

V. C. F.

Applications of Cast Iron in Modern Automobile Construction

(*Continued from page* 404.)

Car performance, as measured by maximum speed and acceleration, has reached a figure which is likely to remain fairly stable for some little time and therefore the most likely trend of development is towards the saving of costs, both in material and in machining. The foundry is able to give a great deal of help in this direction, both in regard to material costs and the saving of machining, by producing castings of such finish, and to such close tolerances, that many parts that in the past were considered to require a machined finish are now left in the "as-cast" condition.

Acknowledgments

The authors wish to express their gratitude to Humber, Limited, Coventry; Vauxhall Motors, Limited, Luton; Ley's Malleable Castings Company, Limited, Derby; The British Cast Iron Research Association; and David Brown & Sons (Hudd.), Limited, for their kind help in collecting much of the data given, and particularly to the Midland Motor Cylinder Company, Limited, for their permission to use the information which forms the background for this Paper.

The Temperaments of Melting Units

(*Continued from page* 400.)

The correct volume of air is an important factor in cupola operation. This point is often overlooked, and many people assume the pressure gauge reading gives an indication as to what volume the cupola is taking. This is a fallacy. The only safe method of measuring volume is by means of a Pitot tube or orifice built in the blast main, or, should a positive type of blower be used, a revolution counter.

The volume should be indicated on a large dial or scale so that the operator can be checking the volume with melting rate constantly. Fan blowers, although cheap in first cost and reliable, are apt to vary the volume of air delivered within wide limits during the melting cycle owing to the fluctuation in cupola resistance. This is more pronounced towards the end of the blow, and, if not checked, has a detrimental effect on the quality of the metal. The Roots blower has not this fault and, although regarded by some people as old-fashioned, it will only deliver a definite volume of air per revolution. The introduction of Vee-rope drives and closer machining limits has done much to limit the noise and belt objection.

In one plant, which had as a blowing unit a turbo-blower, the author installed a Roots blower as stand-by, and although the operator had to walk a considerably farther distance to start the plant up, he would never use the former turbo-blower unless forced. On being asked the reason, he stated that when the Roots blower was used, the furnace was always more regular in operation and required less patching after the blow. This is perhaps explained by the pulsations the blower gives to the blows and the absence of overblowing at the termination of the blow.

The melting rate of a cupola can be varied during the blow by controlling the height of the charges below the charging hole. This, in turn, varies the furnace resistance.

Coke is an important factor in cupola operation, and although analysis may govern the performance of certain cokes, it is not necessarily a controlling factor. When a coke is found to be suitable for a particular furnace, it should be in no circumstances changed.

The lines of the cupola lining should be such that at least six charges will be accommodated below the charging hole. Any number above this will increase the thermal efficiency, but after ten charges have been placed on the furnace, the resistance is such that a high blast pressure would be required to make the furnace melt at its correct speed.

Where continuous casting takes place, a low tuyere belt makes for economy, but for large jobbing work a good well of metal will facilitate operation. The author always favoured the bottom tuyeres being below the belt, as this prevents slag building up in the blast belt.

A low cupola has always been found difficult to work with a high steel mix. Although good results have been obtained, the slightest deviation from the correct practice seems to produce trouble out of all proportion to the deviation. This is not apparent in tall cupolas. With steel mixes a coke ratio of 10 to 1 has been found satisfactory until the steel percentage exceeds 20 per cent., but above this amount a little extra coke is required. This amount is best found by trial.

Many troubles associated with a high steel content are unjustly blamed on the furnace, when probably the trouble is insufficient venting, drying, or damp runners. The size of coke used and weight of individual charges should be kept at a constant arrived at by practice.

TRADE SIROCCO MARK

High-Pressure FANS FOR FOUNDRIES

- FORGE FANS
- CUPOLA FANS
- STEEL PLATE FANS

"Sirocco" High Pressure Fans have been designed for the comparatively high pressures which are necessary in connection with the supply of air blast to Forges and Cupolas, or for work of a similar character. The Fans are soundly constructed to give hard and continuous service with a minimum of attention.

MANUFACTURED IN A WIDE RANGE OF SIZES AND DESIGNS

Write for a copy of Publication Ref. SF 26

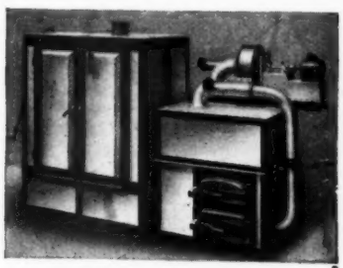
50-ins. Special Double Inlet High-Pressure Fan, dealing with hot gases from Spelter Sintering Furnaces. Driven by direct coupled 110 B.H.P. 440 Volt. D.C. Variable Speed Motor.

DAVIDSON & CO., LTD., SIROCCO ENGINEERING WORKS, BELFAST
LONDON · MANCHESTER · GLASGOW · NEWCASTLE · BIRMINGHAM · CARDIFF · DUBLIN · BRISTOL

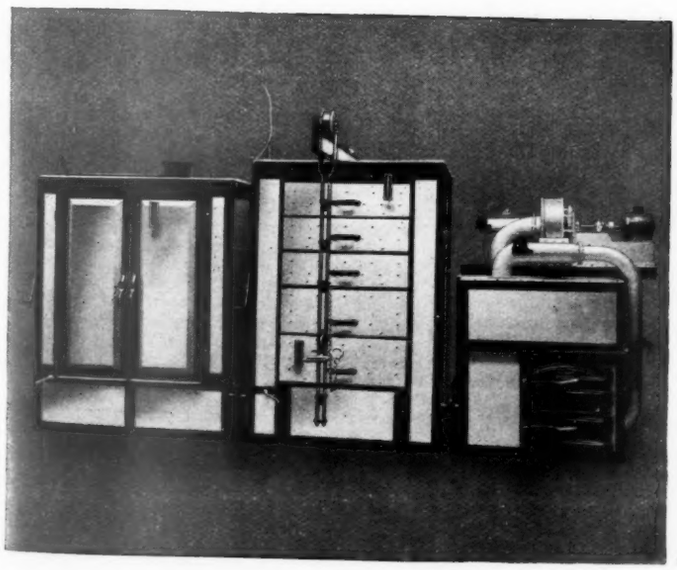
Almost 60 years' experience is behind the trade mark "SIROCCO"

Bomb and Grenade Production demands

HIGHEST CORE-QUALITY with MAXIMUM CORE-DRYING OUTPUT



The Coke-fired "Korex" Tray Cabinet Type Stove with single cabinet will handle the output of
10 Coremakers



The Combination "Korex" Tray Type and "Super Kor" Drawer Type Core Stove will handle the output of
20 Coremakers

INSTALL A TITAN PORTABLE CORE STOVE

THE CONSTRUCTIONAL ENGINEERING Co LTD
Titan Works, Birmingham, 12.
Tel. MID. 4753-4 Telegrams "Structural"

The Week's News in Brief

Trade Talk

J. H. FENNER & COMPANY, LIMITED, power transmission engineers, Hull, have appointed Norman Bell & Company (Pty.), Limited, of Brisbane, as their agents in Queensland, Australia.

THE COMMERCIAL ELECTRIC REFRIGERATION ASSOCIATION has been formed, with offices at 36, Kingsway, London, W.C.2, and Mr. F. A. Rogers as secretary. Mr. E. G. Batt (General Electric Company, Limited) is chairman.

AS AN OUTCOME of a golf match between the (South African) Engineers' and Founders' Association, the Erection Engineers' and the Transvaal Structural Engineers' Associations, the sum of £116 has been sent to the Navy League War Fund.

LORD MCGOWAN, President of the National Safety First Association, speaking at the Association's annual meeting, said that safety-first principles were appropriate to war conditions, for one of the main objects in modern warfare was to reduce to a minimum the vulnerability of our people. A lost-time accident in a factory should be regarded as just as much of a gain to the enemy as a casualty in the armed forces.

CLEVELAND mine-workers are prepared, this year, to forgo their annual holiday, with pay, an arrangement reached between the mine owners and the Cleveland Miners' Association. Should any of the workers express a particular desire, arrangements will be made for them to have their holiday as usual. Whether the men work or not, they will receive holiday pay at the usual rate, also their own supplementary contributions, deducted from wages during the year.

BRITISH TIMKEN, LIMITED, has acquired control of the Fischer Bearings Company, Limited, of Wolverhampton. The directors, in their annual report, state: "The company has entered into a contract with the Custodian of Enemy Property for the acquisition of the entire beneficial interest of the well-known German company Kugelfischer Erste Automatische Guss-stahl Kugelfabrik in its English subsidiary company the Fischer Bearings Company, Limited." In this connection it is proposed to increase the share capital to £400,000 by the creation of 40,000 £1 shares.

TRADE export groups formed in the last two weeks, with the addresses of the secretaries, are:—Gas and Coke Making Equipment—Society of British Gas Industries, Uplands, Epsom Road, Guildford. Gas Meter Makers—98, Brighton Road, Sutton. Gear Manufacturers—Bush House, Room 632, Aldwych, London, W.C.2. Hollow-ware (Cast Iron)—Archibald Kenrick & Sons, Limited, iron-founders, West Bromwich. Chemical Plant—British Chemical Plant Manufacturers' Association, 166, Piccadilly, London, W.1. Underground Mining Machinery Export Group—Cutler's Hall, Church Street, Sheffield, 1.

MR. T. MEEHAN (Divisional Officer), speaking at the annual meeting of the area committee of the No. 2 Division of the Iron and Steel Trades Confederation at Middlesbrough, referred to the position of the industry in the North-East Coast and on the West Coast. Extra time was being worked, he said, at the week-ends to meet the greater pressure due to Government demands. Owing to the arduous nature of operations in iron and steel works, this extra labour was imposing a strain on the workpeople, and this aspect of things would have to be seriously considered when suggestions were brought forward to improve conditions created by the black-out precautions carried out at the works.

A DEFINITE PROSPECT of the foundries in Falkirk and district being utilised in the drive for war materials has been opened up as a result of a visit to Falkirk of Major Bertram Austin, director of area organisation for the Ministry of Supply. Last week he made a tour of several foundries and engineering shops with a view to ascertaining the manufacturing facilities available, and followed this inspection by a meeting with representatives of the town council, the foundry employers, and several trade unions connected with the light castings and engineering industries. At the close of the meeting, Major Austin said he was satisfied from his visit to the foundries that if the employers and employees would get together seriously to consider the manufacture of such things as machine-tool castings, with proper consideration of all the factors that have to be taken into account in that connection, they would come to some understanding and agreement between themselves to get down to work on this new job. He had found a great measure of approval for suggestions which were put forward at the meeting, as well as a desire on the part of all the interests concerned to apply themselves to this new work and to bring about the defeat of the enemy. Provost Begg expressed hopefulness of the outcome of the meeting. Among those who also took part in the discussions was Mr. Tom Cassells, M.P., who has manifested a deep interest in the position of Falkirk's industry.

Personal

MR. W. A. HUBBARD has been re-elected President of the British Oil Burner Manufacturers' Association.

MR. FRANK S. RUSSELL has been elected President of the Yorkshire Firebrick Association. He succeeds Mr. H. J. C. Johnston.

MR. NORMAN BILES, who has for ten years been publicity manager of G. & J. Weir, Limited, of Glasgow, has resigned to join Blackburn Aircraft, Limited, in a similar capacity.

MR. HENRY BOOTH, vice-president of Shawinigan Products Corporation, of New York, has been elected President of the International Acetylene Association, the 40th annual convention of which was recently held in Milwaukee.

MR. W. A. GODSON, of Larbert, has retired after 44 years' service with R. & A. Main, Limited, Gothic Ironworks, Falkirk. At a complimentary dinner presided over by Mr. George Wortley (works manager), a number of gifts were handed to Mr. Godson by Mr. David Gibb, chief of the commercial department.

SIR STEPHEN J. PIGGOTT, managing director of John Brown & Company, Limited, Clydebank, has been awarded a gold medal and certificate "for distinguished service to engineering and science" by the American Society of Mechanical Engineers. The presentation will be made early next month by Mr. Leslie A. Davis, American Consul-General in Glasgow.

MR. JOHN A. SMEETON, of 17, Victoria Street, London, who left England for Brussels by air on Thursday morning, May 9, with a party in order to inspect a new process for the acid pickling of ferrous metals, has related since his return many thrilling adventures he experienced during the following week subsequent to the German invasion of Holland and Belgium, when he played a prominent part in supervising and attending to the comforts of a large number of refugees both prior to and during embarkation at Ostend in particularly trying circumstances.

Wills

WILSON, WILLIAM, retired moulder, of Govan, Glasgow £788

NEEDHAM, OSWALD, retired ironfounder, of John Needham & Sons, Limited, Millgate Foundry, Stockport ... £12,953

Obituary

MR. DAVID MURIE, who carried on business as a brassfounder at Perth for over 40 years before retiring, has died at the age of 75.

Contracts Open

Cork, June 5—Iron, steel, non-ferrous metals, and castings for six months, for the Harbour Commissioners. The Engineer's Department, Cork Harbour.

Cairo, June 15—Positive type reciprocating piston and rotary water-meters, and cast-iron pipes, for Tanzim Department, Ministry of Public Works. (D.O.T. reference: T. 19322/40.)

Pershore, June 1—Providing, trenching and laying of 1,309 lin. yds. of 2-in. cast-iron water main, etc., for the Rural District Council. Mr. F. J. Nicholas, clerk, Council Offices, Pershore. (Fee £2 2s., returnable.)

Reports and Dividends

Triplex Foundry, Limited—Dividend of 5 per cent. for the year to March 31.

R. W. Crabtree & Sons, Limited—Net profit for 1939, £69,510; dividend of 8 per cent.

Jury Holloware (Stevens), Limited—Dividend of 7 per cent. for the year ended March 31.

Edwin Showell & Sons, Limited—Trading profit for the year to June 30, 1939, £3,968; dividend of 10 per cent. on the ordinary shares.

Waygood-Otis, Limited—Profit for 1939, £129,598; ordinary dividend of 25 per cent., and a special bonus dividend of 17½ per cent.

John Thompson Engineering Company, Limited—Net profit, £128,825; brought in, £44,962; dividend of 17½ per cent.; to reserves, £63,000; carried forward, £45,525.

William Dixon, Limited—Net profit, after depreciation and taxation, £64,774; brought in, £27,693; ordinary dividend of 7½ per cent., tax free; carried forward, £28,367.

Associated Manganese Mines of South Africa, Limited—Trading profit for 1939, £59,846; dividend on the ordinary shares of 10 per cent., £25,237; carried forward, £10,487.

Glenfield & Kennedy, Limited—Net profit for the year to March 31, £70,549; final ordinary dividend of 5 per cent., plus a bonus of 7½ per cent., making 17½ per cent. for the year.

Anglo-Greek Magnesite Company, Limited—Profit for 1939, £19,271; brought in, £7,590; to taxation reserve, £6,000; final dividend of 5½ per cent. on the ordinary shares, making 8 per cent. for the year; carried forward, £6,860.

Harland Engineering Company, Limited—Profit for 1939, £19,385; brought in, £14,367; ordinary dividend of 7 per cent.; to general reserve, £5,000; to pensions account, £1,000; written off A.R.P. expenditure, £3,000; carried forward, £14,575.

Park Gate Iron & Steel Company, Limited—Gross trading profit for year to March 31, £223,020; brought in, £45,219; depreciation, £60,000; reserved for taxation, £65,000; debenture interest and sinking fund, £23,000; dividend of 5 per cent., £62,500; to reserve, £10,000; carried forward, £47,739.

Company Meetings

Harland & Wolff, Limited

Commenting on the accounts at the annual meeting of Harland & Wolff, Limited, MR. F. E. REBBECK (chairman and managing director) pointed out that they showed a further improvement over the figures of the previous year, and said this was the more satisfactory because the greater part of the earnings in the year under review had been derived from the company's ordinary commercial activities—shipbuilding, ship-repairing, engineering, etc. He stressed this, because he noticed it was assumed that the increased earnings for the year were entirely the result of work carried out in connection with the country's defence programme. During the current year, however, most of the work in hand was on Government account. All such work was subject to profit limitation.

Stewarts and Lloyds, Limited

In his review of the accounts at the annual meeting of Stewarts and Lloyds, Limited, MR. A. C. MACDIARMID (chairman) said that in the circumstances in which they found themselves to-day they were part of a controlled industry contributing their utmost to the war effort They now owned the whole issued capital of the Stanton Ironworks Company, Limited. The arrangement was working smoothly and efficiently, and there was no doubt in their minds as to the fulfilment of their expectations. Their Australian and South African subsidiaries continued to prosper. Their manufacturing capacity had been increased during the year, and both companies were in a very sound position. The arrangement entered into with the Tata Iron & Steel Company, Limited, for the erection of a large tube works in India was in abeyance on account of the war. Their branches in New Zealand, Egypt and China had had a successful year.

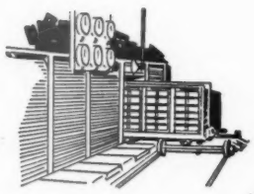
Forthcoming Event

Institute of Vitreous Enamellers

JUNE 11.

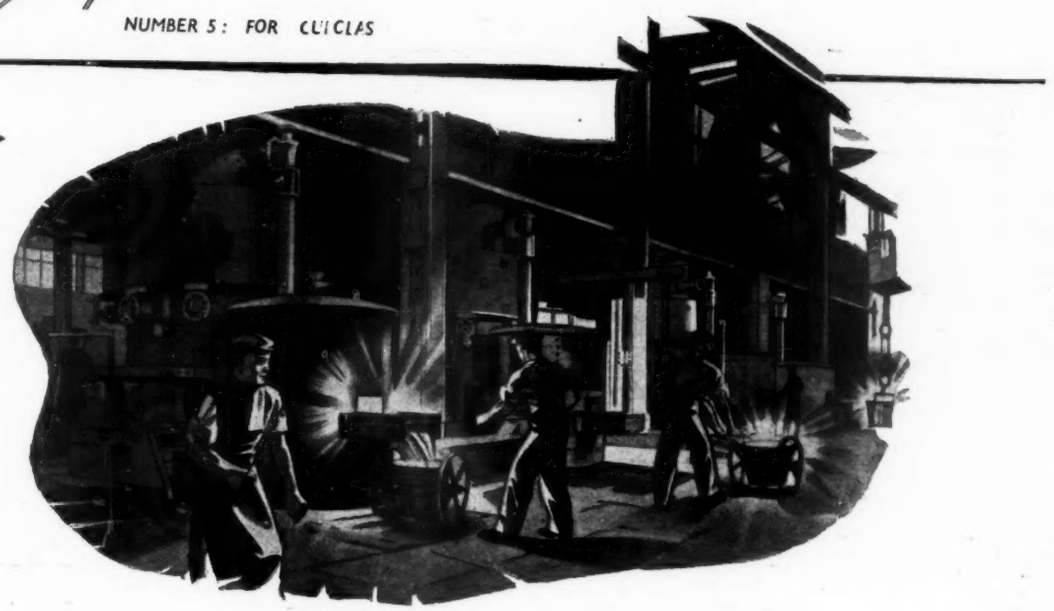
Extraordinary General Meeting:—To consider alteration of Articles of Association, at Chamber of Commerce, New Street, Birmingham, at 2.0 p.m.

REFRACTORIES ON PARADE



YEARS OF RESEARCH HAVE RESULTED IN THE PRODUCTION OF FOUNDRY REFRACTORIES OF PROVED RELIABILITY

NUMBER 5: FOR CUPOLAS



A careful study of the exacting requirements necessitated by modern cupola operating conditions has resulted in the production of cupola refractories which will withstand the most severe conditions to be encountered.

The Technical Department will be very pleased to be consulted on all problems relating to the application of cupola refractories and to make recommendations regarding the most suitable material for individual requirements.

HYCONE
STOUR
WHITE CARR
GLENBOIG
etc., etc.

HAZLEHEAD
GROUND
GANISTER.
GLENDOLINE
etc., etc.

Represent maximum output and freedom from trouble.

always specify GENERAL REFRACTORIES PRODUCT

CONSULT

GENERAL REFRACTORIES

LIMITED

Head Office: GENEFAX HOUSE, SHEFFIELD, 10 Telephone 31113 (6 lines)

Raw Material Markets

The Minister of Supply has issued Direction No. 2, dated May 25, under the Control of Iron and Steel (No. 8) Order, 1940, substituting new schedules of sheet prices for those hitherto ruling, the effect of which is to provide a special price for thick sheets or light plates 3 mm. thick and over when these are rolled on a sheet mill. The demand for this class of material is such that it is necessary to secure production in sheet mills which do not normally roll these thicknesses. In future, the maximum price and extras for sheets or plates 3 mm. thick and over, when wholly rolled down in a sheet mill, will be the same as for sheets immediately below 3 mm. Other prices, including the price of light plates made on plate mills and prices from merchants' stock for plates and sheets, however made, are unaltered.

A seven-day working week is now common at steelworks as well as ironworks, and the extra time put in will add appreciably to output. Every ounce of energy is being put into the munitions drive, and work of a domestic character can only be accommodated as and when the position justifies the despatch of material to other than priority users. Iron for the heavy engineering concerns is in strong demand, but the situation of the light foundries remains unsatisfactory.

Pig-Iron

MIDDLESBROUGH—Local foundries generally are experiencing little delay in acquiring the delivery licences which are necessary before fresh supplies can be obtained. Almost all of the foundry iron used in this area is now being procured from the Midlands, where, although stocks are not high, adequate tonnages are available to meet all demands. The position of light foundries here is variable, some firms having more work on hand than others, but, on the whole, the industry is poorly employed. It seems probable that there will be additional war work placed among the light-castings trade in the near future, but the normal peacetime supporting trades of this section have fallen away very appreciably since the commencement of hostilities.

The virtual cessation of the production of Cleveland iron has left the furnaces free to be employed on the manufacture of other descriptions of iron in greater demand. Hematite makers are very active, but, even so, their full outputs are moving speedily into consumption; much of the hematite made by East Coast furnaces is taken up by local steelworks, but quite a fair tonnage is despatched to users in Sheffield and the Midlands. All new inquiries have to be endorsed by official sanction in the form of licences.

LANCASHIRE—Foundry-iron consumers in this area are obtaining quite good deliveries from the makers in the Midlands. In view of the increasing call for steelmaking iron, it is probable that more furnaces will soon be transferred to the manufacture of steelworks' needs, and this can generally only be done at the expense of the foundry trade. Hence, the position as regards foundry-iron supplies may deteriorate. Consumers as yet have no pressing demands, as only a moderate amount of work is available to this section. Heavy engineers, on the other hand, being very busy, are in the market for large quantities of suitable grades of iron. West Coast hematite is in steady demand.

MIDLANDS—Conditions in the light ironfounding industry are still far from normal and, with prospects of Government work being placed still rather remote, the outlook must be considered difficult. Some relief has been afforded to the foundries which have been able to transfer their plant to the production of machine tools, but it will be some time before the trade as a whole is able to adapt itself to war conditions. High-phosphorus iron is consequently in only moderate request; stocks are small owing to the low rate of production, but there is ample iron on hand to meet all requirements. Consumers of low-phosphorus iron and hematite are busy, mostly on Government orders, and heavy tonnages are being taken up. The supply position a few weeks ago was rather unsatisfactory, but a marked improvement has been noticeable of late.

SCOTLAND—The elimination of idle time at the light-castings works is proving difficult, but there have been further negotiations with the Ministry of Supply, and it is hoped that at least some of the foundries will be able to produce machine-tool castings and other requirements of the Government. Pig-iron is in very insistent demand, and licences for fresh deliveries are granted only when applications show that the material is really needed for important work.

Coke

After a longer delay than was expected, the price of Durham best foundry coke, for delivery to Birmingham and Black Country stations, has been increased by 2s. 6d. per ton, making the price 55s. 6d. Higher railway charges and other factors have made an increase imperative. For some time past makers have been entering into forward business on the understanding that the price paid would be that ruling at the time of delivery, so that the new price is effective on all outstanding contracts. Coke ovens are in a position to make adequate deliveries.

Steel

Priority consumers of steel continue to receive large deliveries, and it is evident that the present system whereby distribution is controlled is having satisfactory results. It is difficult to discriminate between the requirements of the various consumers, as there is a big demand all round. Of late there has been a marked expansion in the call for shell steel, while other munitions requirements are well to the fore. Steelmakers are falling into line with other industrial concerns in the matter of the seven-day week, and outputs are increasing thereby.

Scrap

While large tonnages of old metal are being offered for sale as a result of the national collection campaign, it is still felt in some quarters that additional supplies would be forthcoming were prices to be raised still further. It is pointed out that at many of the sources of supply the owners of the metal, while willing to rid themselves of it, do not find current prices sufficient inducement to sell, as, in many instances, they have not the transport available or the necessary labour to move the disused metal. Reports from all parts of the United Kingdom indicate that local authorities are pulling down railings and other metal not essential to them; in London, Hyde Park has supplied quite a useful amount, while other Royal Parks are being similarly treated. The response of the ordinary householder is increasing weekly, but there continues to be a substantial amount of scrap iron and steel scattered about the Kingdom which is doing nothing more useful than deteriorating in value through exposure to the weather. Now that the whole personnel and property of the nation has been brought under the direct control of the State, the Government will, perhaps, exercise its authority to take up this valuable scrap metal in order to meet the expanding requirements of the consuming works.

Metals

The decision of the International Tin Committee, meeting in London on Monday, to raise the tin quota for the third quarter to 100 per cent. of standard tonnages was much in accordance with market expectations. The new quota compares with the present level of 80 per cent. The *communiqué* issued after the meeting indicates that efforts are being made to expedite exports. The Committee recommends to the signatory Governments that export rights at the 100 per cent. rate for the third quarter should be issued as soon as possible. It suggests that exports against these rights should be permitted prior to the beginning of the third quarter, but subject to adjustment later against export rights for that quarter. A quota of 100 per cent. involves theoretically the quarterly export by signatory countries of 52,244 tons, compared with 41,794 tons at 80 per cent.

The departure of Sir Stafford Cripps to Moscow as head of an economic delegation on behalf of the British Government has aroused keen interest in tin circles, as this commodity, together with rubber, is likely to be one of the chief items in the event of a trade agreement being reached with the Soviet Government. In the last agreement between the two parties tin was to be sent to Russia in exchange for timber, but the decline in diplomatic relations brought about by the Finnish war did not facilitate the full operation of this pact.

Tin consumers in this country are working at a high level of production, especially those connected with Government orders. Trade demand in the United States has slackened slightly of late.

London Metal Exchange prices for tin this week have been as follow:—

Cash—Thursday, £269 10s. to £269 15s.; Friday, £267 10s. to £267 15s.; Monday, £266 15s. to £267; Tuesday, £268 to £268 10s.; Wednesday, £270 to £270 5s.

Three Months—Thursday, £267 5s. to £267 10s.; Friday, £265 5s. to £265 10s.; Monday, £265 5s. to £265 10s.; Tuesday, £265 5s. to £265 10s.; Wednesday, £268 to £268 5s.

Large tonnages of copper continue to arrive at United Kingdom ports from Empire sources, and there is a ready market for it all. It seems likely that additional shipments will be made from Canada in the near future. Quiet conditions continue to prevail in the American market, both home and export business being at a low ebb.

In the United States, there appears to be quite brisk business in bonded zinc on Allied account. A number of French zinc and lead concerns are situated in and around the theatre of hostilities in northern France, while there is the loss of the Belgian and Norwegian sources of supply to be taken into consideration. In this country, priority users of both spelter and lead are receiving large deliveries to meet their increasing requirements, but the distribution of supplies to other consumers is restricted.

In the non-ferrous scrap trade it is hoped that the restrictions on the use of the lower grades of material will be withdrawn, as there is a surplus of these descriptions available at the present time.

I.B.F. Revised Ballot Forms

Owing to circumstances entirely outside the control of the officials of the Institute of British Foundrymen, certain nominations were not included on the ballot form recently sent to all members. A revised ballot form is being prepared. Any ballot forms previously returned to the General Office will be cancelled, and members who sent such forms are requested to vote again on the new form to be sent. For this purpose the ordinary envelope may be used, but it should be marked clearly "Ballot Form."

MAGNETIC SEPARATORS
"RAPID-BIAFLUX" Patent
PULLEY & DRUMS
The Popular
"OVERBAND"
FOR FOUNDRY SANDS
LISTED IN 5 SIZES
LIFTING MAGNETS
FOR PIG IRON & SCRAP
CLUTCHES & CHUCKS
THE RAPID MAGNETTING MACHINE Co., Ltd.,
Magnet Works, Lombard St., Birmingham, 12
'Phone: Victoria 1137-8 'Grams: "Borings, Birmingham."